OFFICE OF RIVER PROTECTION
P.O. Box 450, MSIN H6-60
Richland, Washington 99352

JUN 2 7 2013

13-ECD-0054

Mr. John Martell, Manager
Radioactive Air Emissions Section
Washington State Department of Health
309 Bradley Blvd., Suite 201
Richland, Washington 99352
(Hanford Mailstop: B1-42)

Mr. Martell:

U.S. DEPARTMENT OF ENERGY, OFFICE OF RIVER PROTECTION (ORP) RESPONSES TO AIR OPERATING PERMIT EMISSION UNIT 218, NOTICE OF CONSTRUCTION 877, "OPERATION OF 296-A-19 ANNULUS EXHAUSTER AY-102," CONDITIONS 4 AND 6 ISSUED UNDER WASHINGTON STATE DEPARTMENT OF HEALTH APPROVAL ORDER AIR 13-401

Reference: WDOH letter from J. Martell to K. W. Smith, ORP, "Operation of 296-A-19 Annulus Exhauster AY-102 (NOC 877; EU 218)," AIR 13-401, dated April 15, 2013.

ORP is forwarding the following three requested documents:

- RPP-55198, Revision 0, "AY-102 Ventilation Tank Annulus (VTA) Sampling and Monitoring System Evaluation," (Attachment 1);

- RPP-55197, Revision 0, "ANSI/HPS N13.1 Compliance Matrix for Stack 296-A-19 at 241-AY-102," (Attachment 2); and

- RPP-CALC-55212, Revision 0, "Analysis of AY Annulus Stack 296-A-19 Radionuclide Particulate Sampling Probe," (Attachment 3).

The primary conclusions of these three documents are as follows:

- RPP-CALC-55212 concludes that the aerosol penetration through the sampling assembly will be greater than 50 percent; 50.5 percent if operated isokinetically, and 61.0 percent if operated anisokinetically;

- RPP-55197 and RPP-55198 provide a comparison of the requirements inherent in the American National Standards Institute (ANSI) N13.1-1969 and ANSI N13.1-1999. They conclude that the stack sample probes were designed and installed in accordance with ANSI N13.1-1969; and

- RPP-55198 also recommends that maintenance and operation of the current system is the recommended alternative for future operations of the AY-102 annulus exhauster system.

The above documents were developed to satisfy "Condition 4" (Reference) which is stated as follows:

4) Monitoring – Evaluation schedule requirement
A plan to evaluate the sampling system and continuous air monitoring systems to meet the sampling requirements of ANSI N13.1-1999 will be required by June 30, 2013. The plan will require the following, with dates of completion:
    - A review of the current sampling system efficiencies;
    - Development of technical basis documentation;
    - Evaluation of the current system;
    - Determination of system design needs; and
    - Determination of completion dates for system changes, if needed. (WAC 246-247-060)(5), 246-247-075(3)).

This response is also intended to satisfy the notification requirement specified in "Condition 6" (Reference) which is stated as follows:

6) WDOH NOTIFICATION
WDOH will be notified when the initial inspection to meet 40 CFR 61 App. B Method 114 (4,7), Maintenance and Inspection requirements have been completed. The deadline for this activity will be July 15, 2013.
(WAC 246-247-075(2), WAC 246-247-060(5)).

An inspection of the system was completed in May of 2013. This inspection is documented in RPP-55197, Revision 0.

If you have any questions, please contact Dennis W. Bowser, Environmental Compliance Division, (509) 373-2566.

K. W. Smith

Kevin W. Smith
Manager

ECD:DWB

Attachments: (3)

cc: See page 3

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R. Jim, YN
Administrative Record
BNI Correspondence
Environmental Portal, LMSI
WRPS Correspondence

Attachment 1
13-ECD-0054
(45 Pages)

AY-102 Ventilation Tank Annulus (VTA) Sampling and Monitoring System Evaluation

Dennis W. Bowser

AY-102 Ventilation Tank Annulus (VTA) Sampling and Monitoring System Evaluation

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U.S. Department of Energy Contract DE-AC27-08RV14800

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Key Words: 241-AY-102, Annulus Ventilation, VTA, 241-AY, Sampling, Monitoring, ANSI N13.1, ANSI/HPS

Abstract: This report is in response to the Washington Department of Health revised Notice of Construction (NOC-877) for the 296-A-19 actively ventilated stack for the 241-AY-102 annulus ventilation system

APPROVED
By G. E. Bratton at 9:06 am, Jun 11, 2013

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A-6002-767 (REV 3)

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(2) Title AY-102 Ventilation Tank Annulus (VTA) Sampling and Monitoring System Evaluation			
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(3) Revision	(4) Description of Change – Replace, Add, and Delete Pages	Authorized for Release	
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A-6003-883 (10/04)

AY-102 Ventilation Tank Annulus (VTA) Sampling and Monitoring System Evaluation

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Richland, WA 99352

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Key Words: 241-AY-102, VTA, Annulus, 296-A-19, sampling, monitoring

Abstract: This report is in response to the Washington Department of Health revised Notice of Construction (NOC-877) for the 296-A-19 actively ventilated stack for the 241-AY-102 annulus ventilation system

A-6003-883 (10/04)

241-AY-102 VENTILATION TANK ANNULUS (VTA) SAMPLING AND MONITORING SYSTEM EVALUATION

June, 2013 prepared by M.L.Vosk

Vista Engineering Technologies, Inc.

1355 Columbia Park Trail, Richland, Washington 99352

Prepared for Washington River Protection Solutions.

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ABBREVIATIONS AND ACRONYMS

ACI	American Concrete Institute
AMCA	Air Movement and Control Association
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
CAM	Continuous Air Monitor
CFM	Cubic Feet per Minute
DOE	U.S. Department of Energy
DOH	Department of Health
DST	Double Shell Tank
EU	Emission Unit
FDC	Functional Design Criteria
HEPA	High Efficiency Particulate Air
HPS	Health Physics Society
IEEE	Institute of Electrical and Electronic Engineers
ISO	International Standards Organization
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NOC	Notice of Construction
ORP	Department of Energy Office of River Protection
OSHA	Occupational Safety and Health Administration
ORP	Office of River Protection
PM	Preventative Maintenance
ROM	Rough Order of Magnitude
SDD	System Design Description
UL	Underwriters Laboratories
VTA	Ventilation Tank Annulus
WAC	Washington Administrative Code
WDOH	Washington State Department of Health
WRPS	Washington River Protection Solutions

Executive Summary

This evaluation report is in response to the Washington State Department of Health revised Notice of Construction (NOC-877) for the 296-A-19 actively ventilated stack for the 241-AY-102 annulus ventilation system.

During August and September of 2012 the 241-AY-102 Double Shell Tank annulus was found to have unidentified material in the annulus. The material was sampled, analyzed, and determined to have the radioactive and chemical characteristics of 241-AY-102 Tank waste.

During April of 2013 the Washington State Department of Health (WDOH) requested via conditions included in a revised license (WDOH 2013) that the U.S. Department of Energy Office of River Protection (ORP) and contractor Washington River Protection Solutions (WRPS) prepare a plan to evaluate the existing 241-AY-102 annulus exhaust stack sampling system and continuous air monitoring systems to meet the requirements of ANSI/HPS N13.1-1999. This evaluation plan is required to be prepared and submitted to WDOH by June 30, 2013.

The condition in the revised license states that the following will be included in the response:

1. Perform a review of the current sampling system efficiencies.
2. Develop technical basis documentation
3. Evaluate the current system
4. Determine the system design needs
5. Determine completion dates for system changes if needed.

This report (RPP-55198) addresses each of the five items which are required in the response to WDOH as follows.

1. A review of the current sampling system efficiencies was performed via a conservative calculation using verified and validated industry standard software. As discussed within this report the calculation concludes that the system as currently installed has a deposition efficiency that meets the ANSI/HPS N13.1-1999 performance requirement.
2. A discussion of the technical basis documentation is included in this report. The report identifies the documents which form the original technical basis. The information within the documents is discussed on the basis of the current ANSI/HPS N13.1-1999 definition of technical basis.
3. This report is an evaluation of the current 241-AY-102 Ventilation Tank Annulus system. The report evaluates the original design and technical basis, modifications to the original system including the addition of a record sampler, a discussion of recent inspections of the sampling system, a discussion of ANSI/HPS N13.1-1999 requirements with respect to the current system, a discussion of a deposition efficiency calculation, a codes and standards review, discussion of alternatives, and conclusions.
4. A detailed report (RPP-55197) comparing the current system with respect to the requirements of ANSI/HPS N13.1-1999 was prepared and its findings are discussed

within this report.

5. This report includes an evaluation of alternatives for the 241-AY-102 Ventilation Tank Annulus system. The evaluation includes both ROM cost and schedule. The following table summarizes the evaluation in the report

Alternative	Cost	Schedule
Maintain and operate the current system	No increase or decrease over current costs	N/A
Use passive ventilation only	Slight decrease over current costs	N/A
Perform a sampling system upgrade	$520,000	6 months
Replace the sampling system and stack	$750,000	7.5 months
Use a portable ventilation skid	$85,000 to $1.8M depending on option	6 months to 15 months depending on option

The recommended alternative is to maintain and operate the current ventilation system.

Conclusions reached by this report are:

- A calculation (RPP-11595) performed in 2002 determined the sample probes were designed and installed in accordance with ANSI/HPS N 13.1-1969 and other applicable guidance. Recommended Stack probe position, sample nozzle locations, probe bend radius, near isokinetic sampling, and minimization of particle deposition have all been incorporated in the design, indicating that the probes are adequate for the purposes to which they are applied.
- This report determined that no changes have been made to the sampling system since the time of that calculation. A separate report (RPP-55197) determined that the current system would not meet all requirements of ANSI/HPS N13.1-1999
- The system was designed, installed, and subsequently modified according to the appropriate codes and standards in effect at the time
- Maintenance and operation of the current system is the preliminary recommended alternative

1.0 INTRODUCTION AND BACKGROUND

The U.S. Department of Energy (DOE) received a letter from the Washington State Department of Health (DOH) on April 15, 2013 (WDOH-2013). The letter was a notification of approval of modification and license for operation of Emission Unit (EU) 218, which is the 296-A-19 Annulus Exhauster for the double shell tank 241-AY-102. To comply with Washington Administrative Code (WAC) Chapter 246 – 247, the EU must be operated according to the conditions, controls, monitoring requirements, and limitations of the license. An "Evaluation schedule requirement" was included in the monitoring requirements of the license. This requirement stated: "A plan to evaluate the sampling system and continuous air monitoring systems to meet the sampling requirements for ANSI/HPS N13.1-1999 will be required by June 30, 2013." This report provides the required evaluation of the 241-AY-102 Annulus Sampling and Monitoring System.

2.0 PURPOSE AND ARRANGEMENT

This report has been prepared to evaluate the 241-AY-102 Annulus Exhauster System original design, functions, and efficiencies as well as modifications to these areas during the equipment lifetime as required by the Washington State Department of Health in the operating license. This report also performs a preliminary evaluation of alternatives for 241-AY-102 annulus ventilation system. The report is arranged as follows:

Section 3.0– Is the 241-AY-102 VTA System Description

Section 4.0 – Discusses the original design basis.

Section 5.0 – Discusses the original technical basis.

Section 6.0 – Discusses the modifications to the system over its lifetime.

Section 7.0 – Discusses a system walkdown, which was performed to verify the field configuration against the design documentation.

Section 8.0 – Evaluation of the current record sampling system of the 241-AY-102 with respect to ANSI/HPS N13.1-1999.

Section 9.0 – Discussion of an evaluation performed using Deposition 2001a computer software to determine the record sampling system efficiency.

Section 10.0 – Comparison of the regulatory standards in effect during the design and modification of the existing standards to those which would be in effect for a newly designed radioactive emissions source.

Section 11.0 – Provides preliminary evaluation of alternatives for the 241-AY-102 VTA system. The alternatives are described and for each alternative, the positive and negative impacts along with preliminary schedule and ROM cost are given.

Section 12.0 – Discussion of the recommended alternative.

Section 13.0 – Provides the conclusions of the report.

The body of the report includes the key findings and summary information. Further detail of research and analysis performed is included in the appendices of the report.

3.0 241-AY-102 ANNULUS VENTILATION SYSTEM DESCRIPTION

The 241-AY-102 Annulus Tank Ventilation System (VTA) operates intermittently to support tank farm operations and ventilates the annulus of Double Shell Tank (DST) 241-AY-102. The tank annulus is located between the 75-ft diameter primary tank and the 80-ft diameter secondary liner, forming a nominally 2.5-ft wide annular space wrapping around the entire circumference of the primary tank. The annulus space provides secondary containment for the primary tank. Ventilation of the annulus via the VTA provides the capability to cool the primary tank to reduce thermal stresses, minimizes corrosion due to condensation by removing moisture from the annulus space, and dilutes and removes flammable gas which could be generated if waste were present in the annulus. Tank risers of various sizes are located at the top of the secondary liner and provide access to the annular space. Access is necessary for a variety of activities including, but not limited to, visual inspection via cameras, sampling, ultrasonic testing using crawlers, emergency pumps, and leak detection instruments.

Figure 1 is a photo of the 296-A-19 stack at 241-AY-102. Figure 2 is a VTA system diagram. The VTA utilizes two ventilation trains to control inflow and outflow of air. The incoming air passes through a damper and two pre-filters to reduce particulates entering the tank annulus space. The filtered air enters the annulus space at the bottom center of the tank, allowing better control and even distribution of the temperature within the tank shell. Figure 3 shows the 241-AY-102 Base Configuration, which includes channels that allow the air to enter at the bottom of the tank and to be evenly distributed from the bottom up.

A CAM (Continuous Air Monitor) is located prior to the exhaust HEPA filters and is intended for leak detection only. The annulus air is discharged to the surrounding environment through an exhaust stack after passing through a heater section (heater is out of service), and two banks of High-Efficiency Particulate Air (HEPA) Filters. A portion of the air is pulled from the stream after the HEPA filters for the purpose of record sampling. The sampled air is returned to the stack for discharge.

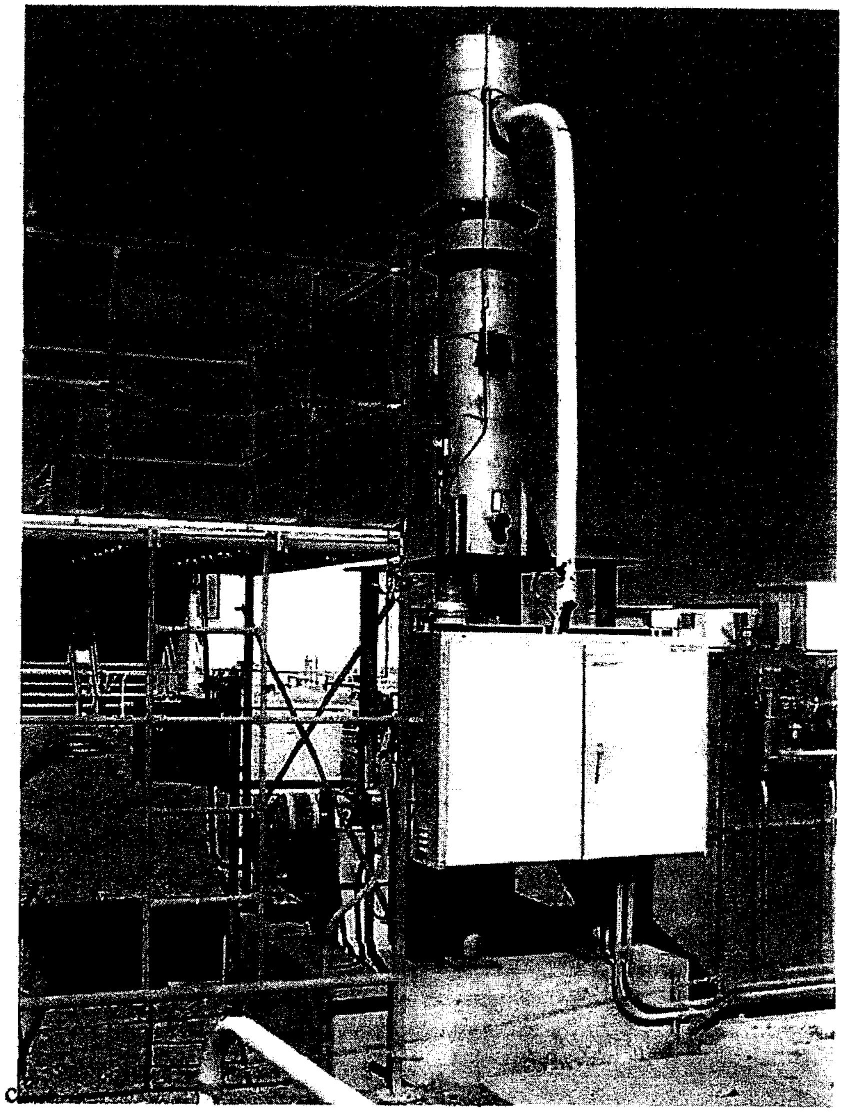

Figure 1 – 296-A-19 Stack at 241-AY-102

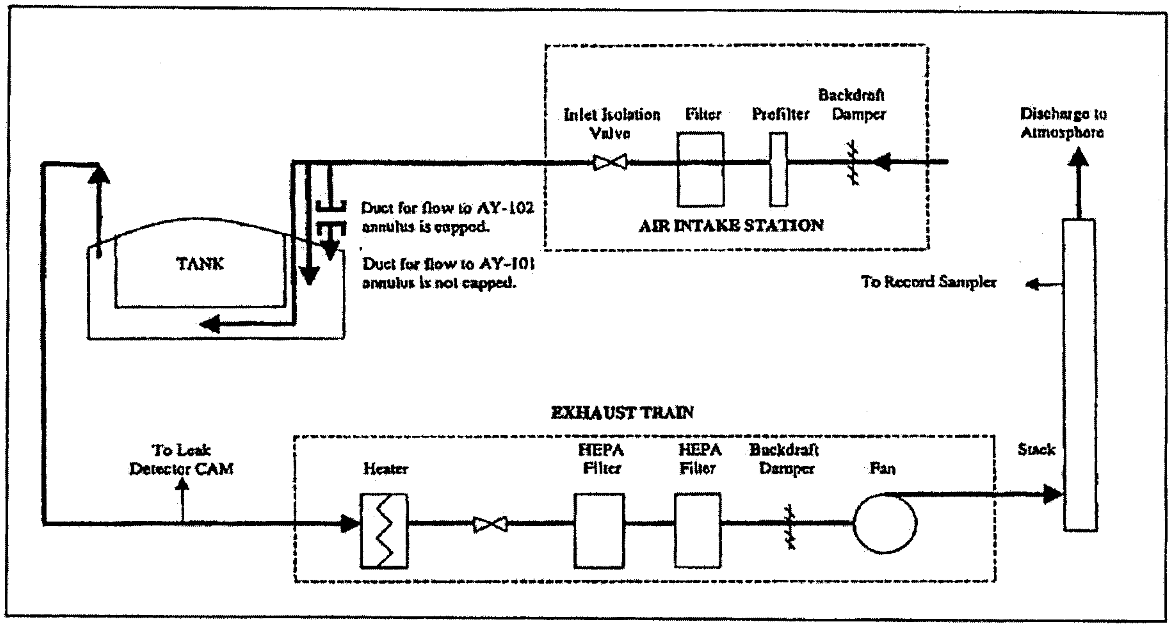

Figure 2 – VTA System Diagram

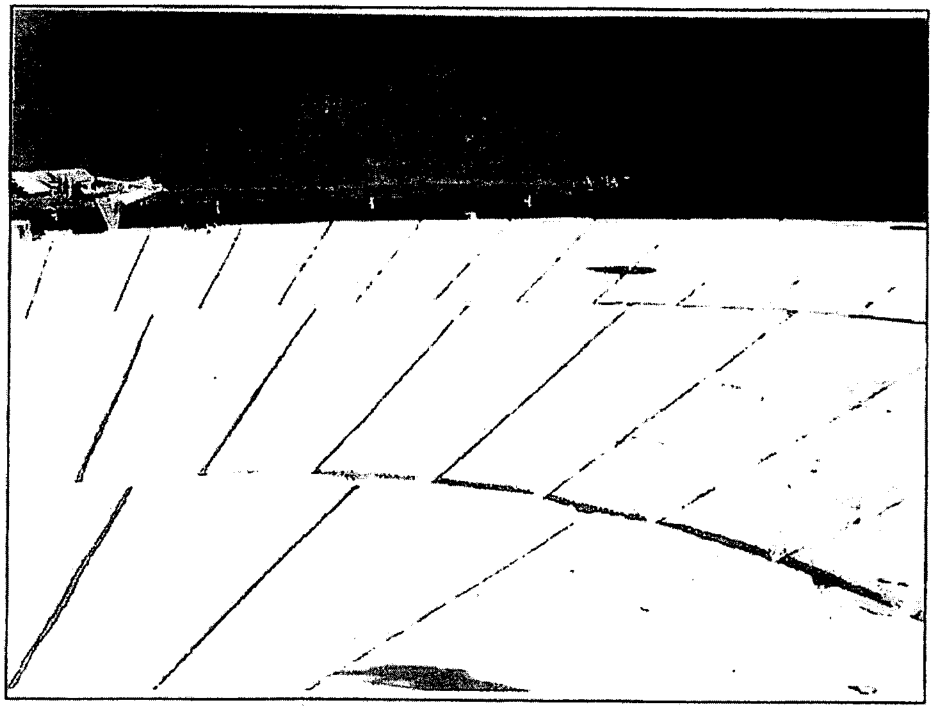

Figure 3 – 241-AY-102 Tank Base

Figure 4 is a configuration diagram, which shows the instrumentation of the sampling system. Figure 5 and Figure 6 are photos of the sampling cabinet and the stack flow indicator. The flow indicator (FI-902) provides the exhaust flow rate through the stack. This stack flow indication is located upstream of the record sample probes and downstream of the flow measurement test ports. As the exhaust air travels up the stack, a portion of the air is pulled into the Record Sampler Enclosure (shown within the dotted lines of the configuration diagram). Inside the Record Sampler Enclosure the air sample flows across the record sampler filter, FLT-930. Flow inside the sampler cabinet is indicated via local flow indicator FI-930 and totaled via the flow totalizer FQI-930. Pressure is indicated via pressure indication PI-931. Lack of flow is indicated via low flow alarm, FSL-932. The flow rate through the cabinet is controlled by the flow control FCV-933 which is located upstream of the record sampler pump, P-934. Flow exits the cabinet and is returned to the stack. The full VTA system P&ID is shown on drawing H-14-020206, Sheets 1-3 from which the diagram information was taken.

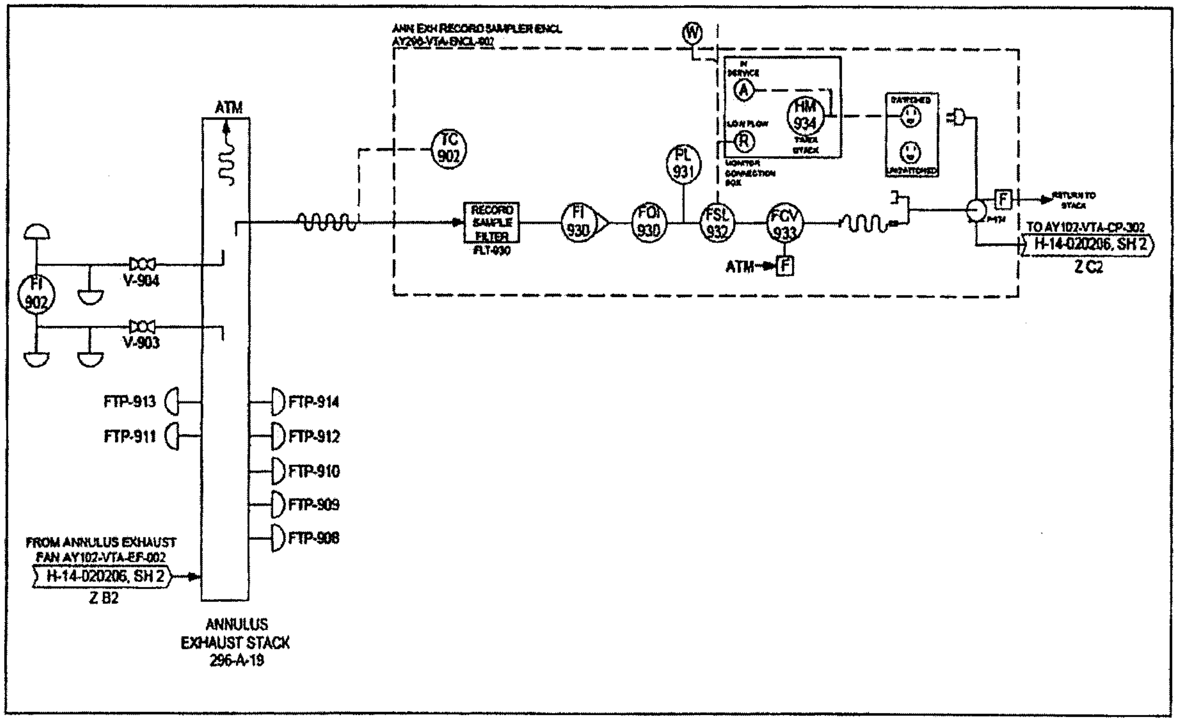

Figure 4 – VTA Sampling System Configuration Diagram

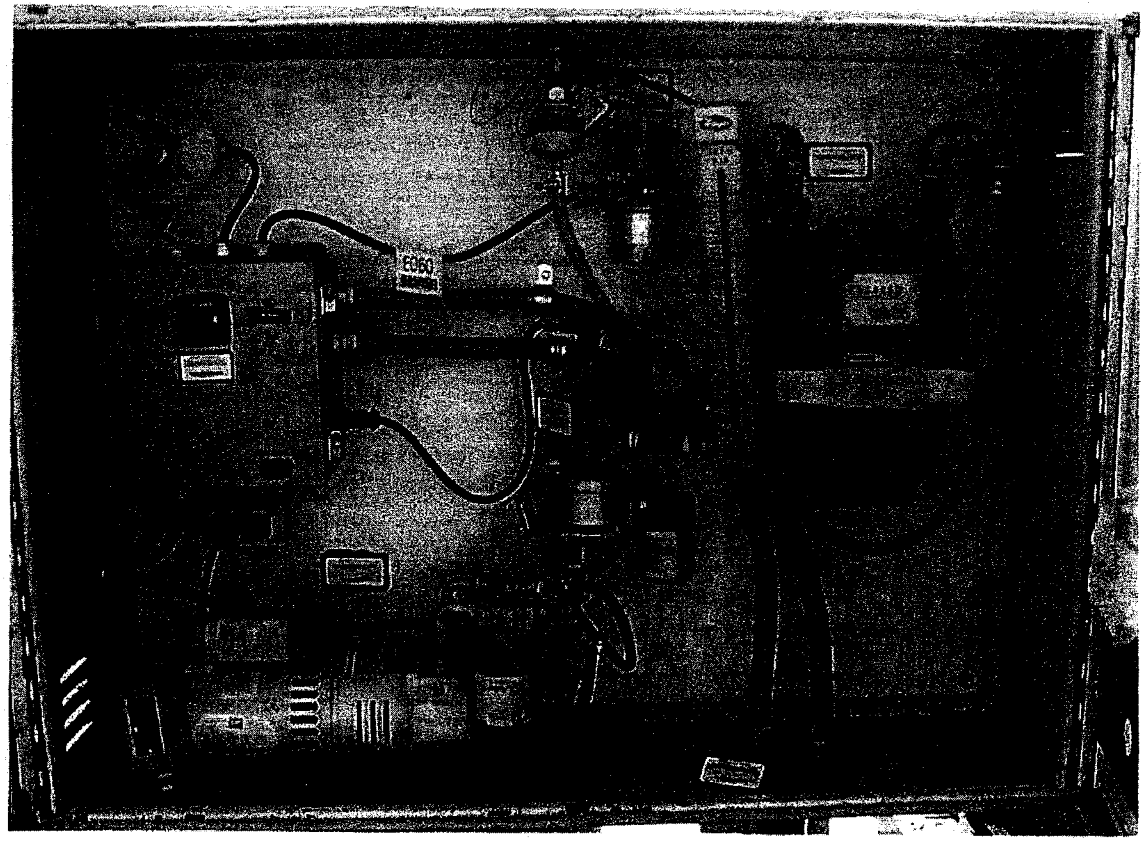

Figure 5 – 296-A-19 Stack Record Sampling Enclosure

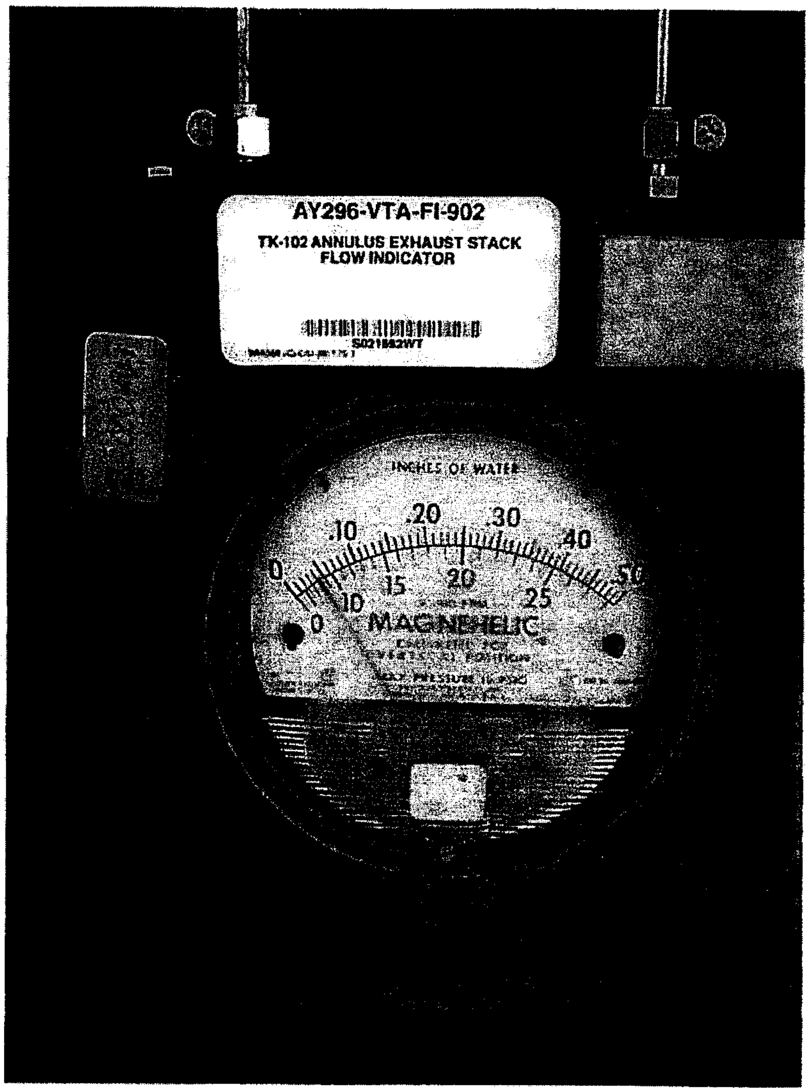

Figure 6 – AY296-VTA-FI-902 TK-102 Annulus Exhaust Local Stack Flow Indicator

4.0 ORIGINAL DESIGN BASIS

When originally designed and constructed between 1968 and 1971, the 241-AY-102 VTA did not include a record sampler therefore there are no record sampling requirements in the original design basis. Since initial construction was completed a record sampling system has been added (see Section 6.0). There have also been two major upgrade efforts in addition to the installation of the sampler. Neither of these two upgrades modified the sampling system (see Section 6.0 and Appendix C) this section discusses only the original design basis.

The design documentation includes specific references to several codes and standards for the 241-AY-102 VTA (see Appendix A). Hanford standards and DOE orders were in effect at the time of design (see Section 10.0), which covered radioactive emissions. Where specific reference to codes and standards was not given, good engineering practice would have included use of the Hanford standards and DOE orders for design and review along with the applicable national codes and standards that were in effect at the time. Research into the original design and functional criteria documents did not indicate that any inappropriate or inadequate codes and standards were used.

5.0 ORIGINAL TECHNICAL BASIS

The VTA system for 241-AY-102 was originally designed prior to the initial release of ANSI N13.1 in 1969. Current requirements for ventilation are found in 40 CFR 61.93 and include ANSI/HPS N13.1-1999. The ANSI standard in effect today (ANSI/HPS N13.1-1999) states that a technical basis for sampling of airborne radioactive materials from stacks must be prepared. While a technical basis as defined in detail in the ANSI standard would not have been required since the standard did not yet exist, good engineering practice would have mandated a technical basis be prepared for the system. Research was performed as described in Appendix B to determine if the original technical basis documentation could be applied to a technical basis as defined by the ANSI standard. Table 1 – Original Technical Basis Comparison to ANSI/HPS N13.1-1999 Technical Basis summarizes the results of the original technical basis research. A detailed comparison to ANSI/HPS N13.1-1999 has also been performed in RPP-55197, which is discussed in Section 8.0.

Table 1 – Original Technical Basis Comparison to ANSI/HPS N13.1-1999 Technical Basis

ANSI/HPS N13.1-1999 Technical Basis Element	Original Technical Basis	Original Source
Sampling Objective	There will be a radiation alarm in the exhaust system	ARH-205
Graded Approach to Meet the Objective	Specification includes a gamma radiation indicating system, consisting of a single channel gamma radiation indicator with adjustable alarm setting.	HWS-7792
Relevant Facility Operating Conditions	Vapor pressure allowance of 60 in. H_20 Vacuum pressure allowance of -6.0 in. H_20 Vapor average cross-section temperature of 200-220 degrees F	ARH-205
Airborne Contaminants	No information could be found related to the original airborne contaminants for sampling purposes	NA
Action Levels	No information could be found related to action levels that would signal a changing condition in the original system	NA

6.0 MODIFICATIONS TO THE 241-AY-102 VTA SYSTEM

This section discusses the modification, which took place in the 1980s to add a record sampler to the 241-AY-102 VTA. In addition to the installation of a record sampling system, two other major modification efforts have been completed since the original installation of the 241-AY-102

VTA System. Research into the modifications indicated that neither modification effort changed any part of the record sampling system which is the focus of the ANSI/HPS N13.1 standard referenced in the Monitoring Evaluation Requirement in the license (WDOH-2013). Details of the modifications are included in Appendix C of this report and are not further discussed in this section.

Research to determine the requirements and drivers for installation of the record sampling system included review of system specifications, drawings, and other design documents as well as interviews with personnel knowledgeable of the history of the system. No definitive single requirement to add record sampling to the 241-AY-102 VTA was discovered. However, there was a Hanford Site wide effort to add record sampling to a large number of locations on site at the time the 241-AY-102 VTA was modified to include the record sampler. A DOE order came into effect a prior to this time and would have been a driver to add record sampling. The DOE Order is:

- DOE Order 5480.1, "Environmental Protection, Safety, and Health Program for DOE Operations,"

A key component of a sampling system is the sampling probes. A thorough analysis of the record sample probes for 241-AY-102 annulus ventilation was completed in 2002 as documented in RPP-11595, *Analysis of AZ and AY Annulus Stack 296-A-18, 19 & 20 Radionuclide Particulate Sampling Probes*. The analysis evaluates the system with respect to the ANSI N13.1-1969 standard. The conclusion of the analysis is that the system was designed and installed in accordance with ANSI N13.1-1969.

7.0 SYSTEM INSPECTION

This section describes a fence line walk-down of the 241-AY-102 VTA performed on May 20, 2013 as well as to document the recent inspection and maintenance actions completed on the system. The intent of the walk-down was to verify the field condition of the VTA matched the design documentation. The only discrepancy noted between the design documentation and field condition was that the record sampler tubing took one long 90 degree turn to vertical down to the cabinet rather than the two 45 degree turns with an angled section of tubing as shown on the drawings.. During the walk-down, recent maintenance and inspections of the system were discussed. Documentation of the inspections and maintenance actions was later provided for review. The maintenance and inspections were as follows:

- A video inspection of the interior of the stack – A copy of the video was provided for review as was a narrative discussing the details of the video and the apparent condition and placement of the nozzles. The narrative notes one minor nick on one of the nozzles that is considered a minor deviation from the sharp edge requirement for nozzles in ANSI N13.1 1969.

  Removal of heat trace and insulation and visual inspection of the sample piping – The bare sample lines were visible during the walk-down. It was stated that there were no significant findings during the visual inspection.

- A bubble leak test – It was noted that in addition to the visual inspection, a bubble leak test was performed on the record sample line leading from the record sample transport line via TFC-WO-13-2168. Bubble leak tests are more sensitive than visual inspection and any significant leak would have been expected to provide indication during such a test. No leaks were noted during the bubble leak test.

- Preventative maintenance actions were performed on the stack flow components. Annual inspections are completed on the record sampling system are completed performed by periodic preventative maintenance (PM) ET-02386 and procedure 6-FCD-077. Stack velocities and volumetric flow rates are tested annually via ET-05944 and procedure 3-VBP-155.

8.0 ANSI/HPS N13.1 REQUIRMENTS EVALUATION

As required by the Monitoring Evaluation Requirement in the modified operation license (WDOH 2013) an evaluation with respect to the ANSI/HPS N13.1-1999 requirements was performed on the 241-AY-102 VTA record sampling system. The detailed evaluation of the system is issued as RPP-55197, *ANSI N13.1 Compliance Matrix for Stack 296-A-19 at 241-AY-102*. This section summarizes the findings of the detailed evaluation.

The ANSI/HPS N13.1-1999 standard, which would be applicable to a new radioactive effluent stack, contains both requirements and recommendations for sampling and monitoring releases of radioactive substances from the ventilation stacks of nuclear facilities. A review of the standard was conducted and the requirements and recommendations were extracted into a requirements matrix within the RPP-55197 report. Each requirement of the standard was evaluated and the documentation reviewed to determine whether the requirement was satisfied. The results were noted in the matrix along with an indication of how the existing system complied.

The report concludes that if ANSI/HPS N13.1-1999 were applied, the system would not be compliant. Procedures were not found for periodic inspections and maintenance of the sampling probe nozzles. There was no testing or computer analysis performed to ensure that the sampling location and design met the requirements of the 1999 standard. In addition to the items listed above, the stack currently does not have a CAM installed to continuously evaluate the effluent stack flow.

9.0 RECORD SAMPLER EFFICIENCY EVALUATION

As required in the Evaluation Schedule Requirement of the modified license (WDOH 2013), an evaluation of the current sampling system efficiencies was performed. The evaluation consists of a calculation using a verified and validated version of Deposition software and the current system configuration. The detailed calculation is issued as *RPP-55212 – Analysis of AY Annulus Stack 296-A-19 Radionuclide Particulate Sampling Probe*. This section summarizes the methods and conclusions of the calculation.

The system was previously analyzed in 2002 as RPP-11595 Rev. 0. The 2002 analysis concluded that the design was compliant with ANSI N13.1-1969.

The Deposition software was first verified and validated to ensure that the installation was completed correctly and that the results obtained were consistent with the results published in the Deposition User's guide. Once the software was verified and validated, the penetration percentages were determined for both isokinetic and anisokinetic probes, each of the three nozzle assemblies, the contraction at end of the probe, the joint, and the transport tube. The average penetration percentage for the three nozzle assemblies was manually multiplied together with the penetration percentages for each part of the sample assembly along with the appropriate probe type to determine the overall penetration percentage. ANSI/HPS N13.1-1999 requires the total combined penetration percentage to be greater than 50%. The calculation includes conservative assumptions regarding the losses for the joint in the transport tube. With these conservative assumptions the efficiency calculated was 50.4% for isokinetic probes and 61.0% for anisokinetic probes.

10.0 REGULATORY, CODES, AND STANDARDS SUMMARY

The 241-AY-102 VTA system's original construction was completed in 1971. The system was designed and installed in accordance with the original technical basis shown in Section 5.0. Since the initial construction was completed, a record sampling system has been added and two major upgrades of other portions of the VTA were also performed. The system modifications were designed in accordance with the codes and standards listed in Section 6.0. The primary focus of the discussion below will consist of three snapshots in time; the initial construction (1971), the design and construction of the record sampling system (1983), and lastly the applicable codes and standards of today (2013).

Appendix D contains a full breakdown of the regulatory, codes and standards summary.

In general, the specific requirements of codes and standards tend to become more stringent due to state, federal, and environmental requirements. Though the revision and some detailed requirements of the codes and standards may have changed since the system was installed and later modified; all codes and standards currently required for a new system were either in effect or were preceded by a code or standard that had the same intent.

11.0 AY-102 VTA SYSTEM ALTERNATIVES EVALUATION

Several alternatives are available for the future 241-AY-102 VTA. Each alternative has positive and negative effects. This section provides the alternatives and discusses the pros and cons, ROM cost and schedule (does not included lifecycle costs), but it is not intended to be a complete alternative/trade study. The alternatives are:

- Use passive annulus ventilation only
- Maintain and operate the system as currently configured
- Perform a stack sampling system upgrade
- Install a replacement stack and sampling system
- Use a portable ventilation skid

A recommendation as to the best alternative is discussed in Section 12.0.

11.1 MAINTAIN AND OPERATE CURRENT VENTILATION SYSTEM

The alternative to maintain and operate the current ventilation system would involve no modifications to the physical configuration of the current system or to the maintenance program and operating procedures already in place.

The positive aspects of this alternative are as follows:

- Cost –There is no cost increase or decrease over the current costs to operate the system.
- Continued use of a proven system familiar to operations and engineering. The current system with a record sampler compliant with ANSI N13.1-1969 has been operating for many years. Operations and engineering are familiar with the system and would not encounter the learning curve for operation and maintenance of a new or modified system.
- By using the existing system funding that would be allocated to upgrade this system can be applied to activities of pumping 241-AY-102 or other higher priority activities.

The negative impacts of the alternative to operate and maintain the current system are as follows.

- While the current system does appear to have been installed and later modified in accordance with the regulations, codes, and standards in effect at the time; the system would not fully meet every criterion that would be applied to a new active ventilation system for radioactive emissions.
- If a gap analysis is needed to justify continued operations there will be a cost and schedule impact.

11.2 PASSIVE VENTILATION

The passive ventilation alternative consists of de-energizing the active 241-AY-102 VTA system entirely and allowing instead only passive ventilation. Passively ventilated sources do not require continuous sampling.

The primary positive aspect of implementing this alternative is that it results in the lowest cost of all the alternatives.

- This alternative reduces the costs of operating the system. By using the existing system in a passive manner, funding that would be allocated to upgrade and operate; the system can be applied to activities of pumping 241-AY-102 or other higher priority activities.

However, the passive ventilation alternative also results in the most negative characteristics of all alternatives. The negative characteristics are as follows:

- There would be no flow to remove flammable gasses that could potentially be emitted by waste in the annulus. The SDD and original design documentation both state that removal of potential flammable gasses is one of the functions of the VTA as designed.
- Without active ventilation, moisture from condensation can build up in the annulus space. This increases the potential for corrosion and rate that corrosion occurs for the primary tank outer wall and the annulus space. Increased corrosion would shorten the tank life and would be detrimental to the tank integrity over time. Both the SDD and the original design criteria include removal of moisture as a function of the VTA as designed.
- A passive ventilation system would not remove significant amounts of heat and tank temperatures could rise.
- There would be an increased likelihood of tank bumps, which are increased pressurization of the headspace of the tank resulting from aerosols generated by heated

gasses on the floor of the primary tank. The Annulus Ventilation System prevents this by moving cooler air across the bottom of the primary tank, thus taking heat away and reducing gas production (RPP-15128, Section 3.4.1.3).

- There would be higher moisture loading on the primary ventilation system. As with a higher temperature within the primary tank, more moisture saturated vapors would be generated. As the vapors leave the tank through the primary ventilation system the vapors condense and are returned to the other AY/AZ tanks.
- The CAM used for leak detection purposes may not work as efficiently. Annulus air would not be flowing through the system to reach the CAM for detection of leaks via radioactive particulates in the annulus air.
- Without the active ventilation keeping the annulus area at a negative pressure, flows through other ports in the annulus such as inspection ports and the ventilation inlet could occur (i.e. fugitive emissions). Currently, the slight negative pressure provided by the VTA keeps flow into the annulus from these openings.

11.3 STACK SAMPLING SYSTEM UPGRADE

This alternative involves a partial update of the ventilation system to upgrade portions of the system with respect to ANSI/HPS N13.1-1999 requirements. This would involve modification of the sampling system to include all requirements and recommendations of the ANSI standard. This would involve modification of the sampling probes and inclusion of features for tracer testing. A CAM would be added to the stack (the current CAM is not a stack cam, it is only used for leak detection) and a new sampling cabinet would be installed.

ROM costs to perform this alternative are as follows:

- Materials - $270,000
- Engineering - $50,000
- Field Work - $100,000
- Miscellaneous costs (procedure changes, testing, etc.) - $35,000
- Stack Certification - $65,000
- Total $520,000

Schedule for completion would be approximately 4 months from start to field installation and turnover. This schedule assumes procurement in parallel with engineering.

The positive impacts of this alternative are:

- The alternative has lower costs than total replacement of the system or procurement of a new portable exhauster skid.
- Upgrading the current system would result in a system that exceeds the codes and standards in effect at the time of its construction and modification. Sampling efficiency could be increased which would decrease the potential for under sampling. A stack CAM would be included to provide immediate indication of radioactive particulates in the

stream exiting the stack.

The negative impacts of this alternative are:

- A partial upgrade would not result in a system that is fully compliant with all detailed criteria of the codes, standards, and regulations that would be applied to a new active ventilation system for radioactive emissions.
- Higher cost than the passive ventilation alternative and the alternative to use and maintain the current system.
- There is a risk that the stack may fail certification.

11.4 REPLACEMENT OF SAMPLING SYSTEM AND STACK

The alternative to install a new replacement sampling system and stack would consist of design, fabrication, installation, startup and testing of a completely new annulus ventilation stack and sampling system that is compliant with all aspects of the current regulations, codes, and standards. This would involve replacement of the fan, stack, and sampling system.

ROM costs to perform this alternative are as follows:

- Materials - $400,000
- Engineering - $75,000
- Field Work - $165,000
- Miscellaneous costs (procedure changes, testing, etc.) - $110,000
- Total $750,000

Schedule for completion would be approximately 6 months from start to field installation and turnover.

The positive impacts of this alternative are as follows:

- A newly designed system would exceed the standards in place at the time of construction and modification of the current system and would be fully compliant with all regulations that would be applied to a newly constructed ventilation system for radioactive emissions.
- This would be a system that is pre-qualified to ANSI/HPS N13.1-1999.

The negative impacts of this alternative are as follows:

- This is the second highest cost alternative and requires the second longest schedule.

11.5 USE OF A PORTABLE VENTILATION SKID

This option is the use of a portable ventilation skid on the 241-AY-102 annulus. The skid used could either be a newly designed and fabricated dedicated exhauster skid, or an existing exhauster skid. Existing skids include a 500 cfm skid (POR06) and a 3000 cfm skid (POR126 or 127). Each sub-alternative is discussed separately within this section

11.5.1 Newly Designed Portable Skid

ROM costs to for installing a newly designed skid are as follows:

- Materials - $1,011,385
- Engineering - $75,000
- Field Work - $250,000
- Miscellaneous costs (procedure changes, testing, etc.) - $100,000
- Total $1,436,385

Schedule for completion would be approximately 15 months from start to field installation and turnover. This includes a 9-month lead-time for procurement.

The positive impacts of this alternative for a newly designed skid are:

- A newly designed portable skid would exceed the standards in place at the time of construction and modification of the current system and would be fully compliant with all regulations that would be applied to a newly constructed ventilation system for radioactive emissions.

The negative impacts of this alternative for a newly designed skid are:

- This is the highest cost alternative and requires the longest schedule.

11.5.2 Use of Existing POR06 Skid

ROM costs to use the 500cfm POR06 skid are as follows:

- Materials - $10,000 (miscellaneous materials to adapt POR06 for use on the 241-AY-102 annulus)
- Engineering - $15,000
- Field Work - $40,000
- Miscellaneous costs (procedure changes, testing, etc.) - $20,000
- Total $85,000

Schedule for completion would be approximately 6 months from start to field installation and turnover.

The positive impacts of this alternative for POR06 skid are:

- The portable skid POR06 is a proven design and is of a newer construction than the existing 241-AY-102 VTA system.
- The portable skid includes ANSI/HPS N13.1 –1999 compliant stacks and sampling systems. A stack CAM is also included.

The negative impacts of this alternative for use of the POR06 skid are:

- The skid POR06 has a limited (500 cfm) capacity
- Skid POR06 would not be available to support its current typical functions of SST ventilation during retrieval and use on miscellaneous tanks for containment and water evaporation.

11.5.3 Use of POR126 or POR127

ROM costs to use the 3000 cfm POR126 or POR127 skid are as follows:

- Materials - $1,500,000 (assumes replacement of existing skid to support retrieval work)
- Engineering - $60,000
- Field Work - $100,000
- Miscellaneous costs (procedure changes, testing, etc.) - $100,000
- Total $1,760,000

Schedule for completion would be approximately 12 months from start to field installation and turnover.

The positive impacts of this alternative for POR126/127 skid are:

- The portable skids POR126 and POR127 are proven designs and are of a newer construction than the existing 241-AY-102 VTA system.
- The portable skids include ANSI/HPS N13.1–1999 compliant stacks and sampling systems. A stack CAM is also included.

The negative impacts of this alternative for use of the POR126/127 skid are:

- Modifications to the inlet side of the VTA system would be necessary to accommodate the 3000 cfm flow rate. These modifications would include at a minimum the addition of a vacuum relief.
- Skid POR126 (or POR127) would not be available to support its current typical functions of primary ventilation for DSTs or ventilation of multiple SSTs during retrieval operations. Procurement of a replacement skid would be necessary to support retrieval operations.

12.0 RECOMMENDED ALTERNATIVE

The preliminary recommended alternative for the 241-AY-102 Annulus VTA is to maintain and operate the current system. This alternative avoids the negative impacts associated with the passive ventilation alternative such as potential buildup of flammable gasses, increased potential for corrosion and increased waste temperature. The options of partial upgrade, complete replacement, and a new portable exhauster skid all have considerable negative costs and schedule impact. The only negative impacts of the recommended alternative are that the system does not meet some of the detailed requirements that would be included in a design for a new radiological ventilation system. However, in depth research into the system design, both original and for modifications, did not indicate any inappropriate use of codes, standards, or materials. The system was designed and installed to the codes and standards in effect at the time of design and modification. The high level system functions of filtration and sampling necessary for a newly designed system are also functions of the current system. The current system design and operating parameters are well defined and do not have the learning curve inherent to new designs. A conservative analysis was performed on the current configuration of the sampling system and the deposition efficiency is shown to meet the ANSI/HPS N13.1-1999 efficiency requirement. In summary, operation and maintenance of the current system is the recommended alternative because it has low negative impacts, appropriate codes, standards, and materials were used in its design and subsequent modifications, it provides the same high-level functions as a newly designed system, and has been shown to have a sampling deposition that would meet the ANSI/HPS N13.1 – 1999 standard.

13.0 CONCLUSIONS

Based on a review of the design documents for the 241-AY-102 VTA record sampling system, the record sampling system has not been modified since its original addition to the VTA. Since no modifications have been made to the sampling system or to the overall system since the 2002 analysis was performed, the conclusion within the analysis that the system met the ANSI N13.1-1969 requirement would remain valid.

A conservative analysis was performed on the current configuration of the sampling system using industry standard software, Deposition. The calculation found that when the methods of ANSI/HPS N13.1-1999 are applied, the calculated total combined penetration percentage is greater than the required 50% for both isokinetic and anisokinetic probes. Therefore, the current sampling rake configuration would meet the ANSI/HPS N13.1-1999 efficiency requirement if applied.

The VTA was constructed to the codes and standards in effect at the time of original construction and subsequent modifications. Though the revision number and some detailed requirements of the codes and standards may have changed since the system was installed and later modified; all codes and standards currently required for a new system were either in effect or were preceded by a code or standard that had the same intent.

Operation and maintenance of the current system is the recommended alternative because it has low negative impacts, appropriate codes, standards, and materials were used in its design and subsequent modifications, it provides the same high level functions as a newly designed system, and has been shown to have a sampling deposition that would meet the ANSI/HPS N13.1–1999 standard.

14.0 REFERENCES

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40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," Title 40, *Code of Federal Regulations*, Part 61, as amended.

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ARH-205-1967, *Design Criteria PUREX AY Tank Farm,* Rev 3, Atlantic Richfield Hanford Company, Richland, Washington.

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Hanford Site Drawings:

- H-2-64462, P&ID Tank 241-AY-102 Annulus.
- H-2-64465, Ventilation Exhaust Equipment Plan and Detail.
- H-2-91069, 296-A-18 and 296-A-19 Record Sample Probes.
- H-2-91982, Exhaust System Modifications.
- H-2-93374, 241-AY-102 Annulus Exhaust Stack Monitor Installation.
- H-2-77326, Piping Details TK-102 241-AY Tank Farm.
- H-14-020206, Ventilation Tank Annulus (VTA) O&M System P&ID.

HWS-7792, 1968, *Specification for Completion of 241 AY PUREX Tank Farm Expansion* ,Rev. 1, Hanford Engineering Services, Richland, Washington.

RPP-11595, 2002, *Analysis of AZ and AY Annulus Stack 296-A-18, 19 & 20 Radionuclide Particulate Sampling Probes*, Rev 0, CH2M Hill, Hanford Group Inc., Richland, Washington.

RPP-15128, 2012, *System Design Description AY/AZ Tank Farms Ventilation Tank Annulus Systems*, Rev 2, Washington River Protection Solutions, Richland, Washington.

SD-672-FDC-001, 1986, Functional Design Criteria 102-AY Annulus Ventilation Duct Upgrade, Rev 0, Rockwell Hanford Operations, Richland, Washington.

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WHC-S-0443, 1995, *Specification for Annulus Ventilation System Electrical Equipment Rack*, Rev 0, Westinghouse Hanford Company, Richland, Washington.

APPENDIX A
ORIGINAL DESIGN BASIS

ORIGINAL DESIGN BASIS

The original design basis for the 241-AY-102 Annulus Tank Ventilation System was researched for this report to provide insight into the original functions and requirements for the system. This background will provide a starting point for the original system to understand its capabilities and to provide insight into why later modifications were performed. Specific codes and standards are called out in the specifications. Additionally, the specifications call for use of "appropriate" and "suitable" codes. As discussed within this appendix, codes and standards for radiological ventilation systems were in effect when the system was designed and constructed and good engineering practice would have dictated their use during design and their consideration during design reviews.

A key finding of research into the original design basis was that when originally constructed, the 241-AY-102 Annulus Tank Ventilation System did not include a record sampler and accordingly there are no record sampling requirements in the original documentation. The 241-AY-102 VTA system's original construction was completed in 1971 however the design was completed in 1968. Research indicates that the original design basis included the applicable codes and standards at the time of design. The system has undergone two major modification efforts since original design. These modification efforts and their design basis are discussed in a separate appendix, this appendix discussion applies only to the original design basis.

According to the System Design Description (SDD, RPP-15128) for the 241-AY-102 Annulus ventilation system, the initial design requirements for the system are located in ARH-205, *Design Criteria PUREX AY Tank Farm*. The SDD goes on to say that, "the components were designed and installed in accordance with the applicable codes and standards that were in effect at the time the system was installed" and "the original functional design document for the AY Tank Farm (ARH-205) does not specifically identify the codes and standards that were used for the original tank farm design".

The fabrication, material, and testing codes for the original annulus ventilation system are listed in the construction specification: HWS 7792, *Specification for Completion of 241 AY PUREX Tank Farm Expansion*. Review of the specification did not result in identification of any substandard or inappropriate material used for construction of the system.

Division III of the HWS 7792 specification states the following code and standards were used for the fabrication, installation and testing of the annulus vent piping:

- Section 8, Installation of Piping, indicated that all piping shall be fabricated and installed per USAS B31.1.0 1967.
- Section 9.1 defines the visual inspection requirements. These requirements match those defined in USAS B31.1.0 as well as HW-4926-S, which is referenced in Division VI for HVAC.
- Section 11.2 defines the annulus piping as pipe code class M-15 with a hydrostatic test pressure of 50 psig.
    - Section 12 – Pipe Code M-15 requirements:
    - Pipe material per ASTM A283-67 or A245-64 grades A, B, C or D.
    - Pipe to have straight seam, resistance welded, beveled ends per AWWA C201.

- o Pipe coating per Fed. Spec. TT-P-28c.

The design criteria document ARH-205, *Design Criteria PUREX AY Tank Farm* contains the original engineering design criteria. Review of the design criteria applicable to the VTA and annulus did not indicate that any of the original design criteria were inappropriate or inadequate. The following were listed within ARH-205 as criteria:

- The Maximum amount of air required for air purge of the annulus will be 2000 CFM. The basis for the 2000 CFM requirement is not documented. As the primary functions of the system were moisture removal to guard against corrosion and heat removal, it is reasonable to assume that a "maximum required" flow was intended to mean that as long as 2000 CFM or more flow was designed into the system capability the functions of moisture removal and heat removal could be adequately met.

- Part of the air is to be delivered to the bottom center of the tank. (Air flow to the bottom of the tank provides cooling to the high-heat sludge waste settled at the bottom of the primary tank).

- The blower system shall be designed to supply any proportion of the total maximum 2000 CFM air.

- The pipe bringing air through the insulation mat to the center of the tank shall be sized to fit into the minimum thickness of insulation required to meet the maximum allowable concrete temperature of 350 F for the base slab.

- Openings into the annulus shall be as follows: A) two 24-inch openings 180 degrees apart, B) two 12-inch openings 180 degrees apart and 90 degrees to the 24-inch openings, and c) 12 three-inch ports spaced between the larger openings. These ports provide access to the annulus for inspection and insertion of equipment or instrumentation.

- The exhaust air shall be properly treated to remove radioactive contamination prior to discharge to the atmosphere. Details of "proper treatment" are not included in the design criteria. However as discussed in the Regulatory and Codes and Standards Comparison section of this report, military specifications, Hanford and other DOE site standards, and ASHRAE standards were in existence and would have fit the definition of proper treatment at the time of initial design.

ARH-76, 1967, *Design Considerations for the 241-AY Tank Farm* is a report containing the design considerations for the 241-AY Tank Farm which includes the 241-AY-102 tank. During review of these considerations no inappropriate or inadequate considerations were discovered. ARH-76 includes the following specific criteria for the annulus ventilation system:

- Sloped laterals or channels (should be considered) in the insulation layer between the primary steel liner base and the secondary liner base allow leakage to travel to the annulus where it can be detected and removed.

- Cooling and ventilating air for the annulus is to be introduced in the insulation layer at the center of the tank and travels into the annulus via the channels provided for leakage.

- Air is to be removed from the annulus via a suitable filtration system and an exhauster. Specific requirements of the filtration system and exhauster are not given. As already discussed, military, Hanford, other DOE site, and ASHRAE standards did exist that would have fit the definition of "suitable".

RPP-15128, *System Design Description AY/AZ Tank Farms Ventilation Tank Annulus Systems* is a document which describes the system, its design basis, and design documentation. Review of RPP-15128 resulted in the following items of significance with respect to the original system:

- Upgrades to the AY VTA systems since original construction have replaced almost all original components. Components from the original 241-AY-102 VTA system that are still in place are the stack and the exhaust heater which is out of service. This would imply that with the exception of the stack itself and the out of service heater, all other portions of the system have been designed or reviewed against criteria which may differ from the original design criteria.

- No instrumentation and control requirements were identified in the original tank farm project functional design criteria, ARH-205. This finding is consistent with the original functions of the system to provide moisture and heat removal which would have required very little in the way of instrumentation and controls.

- An extensive search for documented structural analyses for the original components of the 241-AY-102 VTA was unsuccessful. No structural design requirements for the ventilation system are listed in ARH-205. This finding is consistent with the original function of the system which would have been neither safety class or safety significant. No special requirements for structural design would be expected for such a system.

Annulus ventilation requirements from SD-672-FDC-001 *Functional Design Criteria 102-AY Annulus Ventilation Duct Upgrade Project B-672* is a document which describes the functional design criteria for one of the major modifications to the system. The following statements of note were found during review:

- The scope of this project will be limited to upgrading the underground annulus ventilation piping between the annulus ventilation equipment pad and the 102-AY Tank (ref. SD-672-ES-001). The underground annulus ventilation piping would not have any significant impact on the filtration or sampling portions of the system. These modifications were upgrades only to replace degraded piping and did not change the function of the piping.

- Design of the 102-AY annulus ventilation piping upgrades shall be primarily based on, but not limited to, the approved design criteria for the 241-AY Tank Farm, as applicable. Again, this indicates that the function of the underground piping did not change; the piping was only upgraded to replace components that had degraded over time.

APPENDIX B
ORIGINAL TECHNICAL BASIS

ORIGINAL TECHNICAL BASIS

The original VTA system for 241-AY-102 was designed prior to the initial release of ANSI N13.1 in 1969. Current requirements for ventilation are found in 40 CFR 61.93 and include ANSI N13.1-1999. The ANSI standard states that a technical basis for sampling of airborne radioactive materials from stacks must be prepared. A technical basis as described in detail in the ANSI standard would not have been required since the standard did not yet exist, however good engineering practice would have mandated technical basis for the system. This section describes a review of original system documentation against the current N13.1 definition of a technical basis.

According to the ANSI standard, the technical basis for sampling should address the sampling objective, the graded approach for meeting the objectives, the relevant facility operating conditions and airborne contaminants, and the action levels that signal changing conditions of significance.

The original Design Criteria for the PUREX AY Tank Farm (ARH-205) states that there will be a radiation alarm in the exhaust system. The original design criteria do not include any other sampling objectives or equipment.

The original specification for the PUREX tank farm expansion (HWS-7792) includes a gamma radiation indicating system, consisting of a single channel gamma radiation indicator with adjustable alarm setting. However, later documentation (RPP-11595) indicates that a radiation alarm for the 241-AY-102 VTA was never installed. No other information regarding additional or other equipment to meet the objective of detecting radiation presence in the exhaust was found.

The original facility operating conditions for the 241-AY tanks are stated in ARH-205. Operating conditions relevant to the original technical basis for the sampling system include:

- Vapor pressure allowance of 60 in. H_20
- Vacuum pressure allowance of -6.0 in. H_20
- Vapor average cross-section temperature of 200-220 degrees F

No information could be found as to what airborne contaminants the system was originally designed to detect. The current Washington State Department of Health (WSDOH) license (AIR 13-401 NOC 877) states that total Alpha and total Beta are to be measured. The license also includes the possession quantity of radionuclides which are as follows:

Table B1 – Possession Quantity of Radionuclides

Radionuclide	Curies/year	Radionuclide	Curies/year	Radionuclide	Curies/year
Ac-227	9.30E-03	Am-241	5.10E+03	Am-243	2.8E+00
Ba-137	6.80E+05	C-14	9.40E-01	Cd-113	5.00E+01
Cm-242	5.70E+00	Cm-243	2.20E+00	Cm-244	5.10E+01
Co-60	8.0E+01	Cs-134	4.20E+01	Cs-137	6.80E+05
Eu-152	6.60E+01	Eu-154	6.60E+03	Eu-155	2.70E+3
H-3	1.50E+01	I-129	5.00E-01	Nb-93	4.70E+01
Ni-59	2.50E+01	Ni-63	2.30E+03	Np-237	3.90E+00
Pa-231	7.90E-02	Pu-238	6.30E+01	Pu-239	1.60E+03
Pu-240	3.80E+02	Pu-241	2.70E+03	Pu-242	2.50E-02
Ra-226	9.10E-05	Ra-228	4.40E-02	Ru-106	6.10E-04
Sb-125	3.40E+01	Se-79	4.40E-01	Sm-151	8.30E+04
Sn-126	1.70E+01	Sr-90	4.70E+06	Tc-99	1.90E+02
Th-229	3.80E-05	Th-232	5.40E-02	U-232	2.70E-03
U-233	2.00E-01	U-234	7.40E-01	U-235	3.10E-02
U-236	2.30E-02	U-238	6.90E-01	Y-90	4.70E+06
Zr-93	5.70E+01				

Note: From WDOH letter approving the modified license (WDOH 2013).

For record sampling, the current license states that the sample will be analyzed, at a minimum, for Sr-90, Cs-137, and Am-241.

No information could be retrieved regarding original action levels that would signal a significant changing condition.

APPENDIX C
MODIFICATIONS TO THE SYSTEM

MODIFICATIONS TO THE SYSTEM

Two major modification efforts and the addition of a record sampler were completed since the original installation of the 241-AY-102 VTA System. The first modification in the 1980's replaced underground ducting due to corrosion damage. The addition of a record sampler occurred in the mid 1980's and the second set of major modifications occurred between 1996 and 2001, which replaced significant portions of the overall system and performed the necessary maintenance actions. Within this appendix the addition of a record sampler is discussed first as it is the focus of the ANSI N13.1 standard referenced in the Monitoring Evaluation Requirement in the license approval (WDOH-2013).

Record sampling capability was added to the 241-AY VTA in the mid-1980s. Research included review of system specifications, drawings, etc. and interviews with key personnel. No definitive single requirement to add record sampling to the 241-AY-102 VTA was discovered. However, there was a Hanford Site wide effort to add record sampling to a large number of locations on site (estimated to be about 68 locations). The record sampler system design used for this effort is documented on the drawings listed on H-291841, "Generic Stack Monitor Assembly Drawing Index." (Interview with Jim Criddle, on May 20th 2013). There was no specific requirements document issued for this re-fit effort to add record sampling. However, there was a DOE order that came into effect prior to this time which would have been a driver to add record sampling. The DOE Order is:

- DOE Order 5480.1, "Environmental Protection, Safety, and Health Program for DOE Operations"

DOE Order 5480.1 was later split into two DOE Orders which are DOE Order 5400.1 and DOE Order 5400.5. General Environmental Protection Program information was extracted from DOE Orders 5400.5 and 5400.1.The regulatory guides identify those monitoring and surveillance elements that are considered high priorities for a radiological effluent monitoring and environmental surveillance program. In the regulatory guides, these high-priority elements are written as procedures and activities that "should " be performed, and what is intended as guidance is written as procedures and activities that "should" be performed. The regulatory guide both incorporates and expands on requirements embodied in DOE 5400.5 and DOE 5400.1." This is consistent with the basis for adding record sampling to 241-AY-102 VTA (Interview with Jim Criddle, May 20th, 2013).

The design of the record sample probe specially for 241-AY-102 VTA is documented on H-2-91069, *296-A-18 and 296-A-19 Record Sample Probes*, and was completed in 1983 (296-A-019 is the exhaust stack designation for 241-AY-102 VTA). Note 5 on drawing H-2-91069 states, "Probes sized to provide near isokinetic sampling at 2.2 cfm sample extraction rate and 774 fpm stack flow velocity (15in stack at 950 cfm)." The AY stack flow rates given in RPP-11595 are 892 CFM.

A thorough analysis of the record sample probes was completed in 2002 as documented in RPP-11595, *Analysis of AZ and AY Annulus Stack 296-A-18, 19 & 20 Radionuclide Particulate Sampling Probes*. The analysis evaluates the system with respect to the ANSI N13.1-1969 standard. The conclusion of the analysis is that the system was designed and installed in accordance with ANSI N13.1-1969

Based on a review of the design documents for the 241-AY VTA record sampling system, the system has not been modified since its original addition to the VTA. The installation of the record sampling is documented on drawings H-2-93373 and H-2-93374 (both titled), *241-AY-102 Annulus Exhaust Stack Monitor Installation*.

In the late 1980's, the underground annulus ventilation ducting for the AY tanks was replaced due to piping corrosion. This piping replacement was the first major modification since the original system was installed. The design criteria document for this effort is SD-672-FDC-001, Functional Design Criteria 102-AY Annulus Ventilation Duct Upgrade, Project B-672. According to the document, the redesigned piping was to maintain the required operating specifications for the 102-AY VTA. This document states that the following regulations, codes and standards were to be used in the design and construction efforts:

- DOE Order 5480.1A, "Environmental Protection Safety and Health Protection Program for DOE Operations,"
- DOE and RL Order 5480.4, "Environmental Protection Safety and Health Protection Standards.,"
- DOE Order 5484.1, "Environment Protection Safety and Health Protection Information Reporting Requirements,"
- DOE Order 5820.2, "Radioactive Waste Management,"
- DOE Order 6430.1, "General Design Criteria for Department of Energy Facilities,"
- DOE-RL Order 5480.10, "Industrial Hygiene Program,"
- DOE-RL Order 5480.11, "Requirements for Radiation Protection and Liability Act Program,"
- DOE-RL Order 5700.1A, "Quality Assurance,"
- DOE-RL Order 5700.2A, "Project Management Systems,"
- RHO-MA-100, Policy 8-04, "Control of Employee and Environmental Exposures,"
- RHO-MA-139, "Rockwell Hanford Operations Environmental Protection Manual,"
- RHO-MA-172, "Radiation Work Permits,"
- RHO-MA-201, "Hazardous Material Packaging, Shipping, and Transportation Manual,"
- RHO-MA-220, "Radiological Standards and Operational Controls,"
- RHO-MA-221, Vol. I and II, "Accident Prevention Standards."

The FDC explicitly states, "In addition to the above standards, applicable Hanford Plant Standards, Occupational Safety and Health Act (OSHA) Standards, and "National Consensus" codes and standards as developed by such organizations as the American Society of Mechanical Engineers (ASME), American Concrete Institute (ACI), American National Standards Institute (ANSI), and the Institute of Electrical and Electronic Engineers (IEEE) shall be used as required." Specific mention is given to ANSI N509 and N510 as follows: "Design and fabrication of new piping shall comply with ANSI N509 and testing shall comply with N510." Nothing was found during research of the first major upgrade effort that would indicate any of the codes and standards or design requirements were inappropriate or inadequate.

Between 1996 and 2001, the intake stations, exhaust filter trains, and exhaust fans for AY tanks 101 and 102 were replaced which constituted the second major upgrade to the system since its original installation. Codes and standards to be followed are identified in various specifications for the upgrade. The specifications for the AY Tank Farm VTA upgrades are as follows:

- WHC-S-0418, Specification for Vendor Services and Parts Required to Support Replacement of Fans K1-3-2 and K2-3-2, Annulus Vent Fans Located in 241-AY Tank Farm,
- WHC-S-0424, Specification for Annulus Ventilation Systems Inlet Filter Assemblies at 101 & 102-AY,
- WHC-S-0434, Specification for Vendor Services and Parts Required to Support the Replacement of Annulus Exhaust HEPA Assemblies K1-5-1/K1-5-2 and K2-5-1/K2-5-2,
- WHC-S-0443, Specification for Annulus Ventilation System Electrical Equipment Rack.

The specific codes and standards and other requirement documents from these specifications are as follows:

- From WHC-S-0418:
  - AMCA Publication 99, HVAC Standards Handbook,
  - ISO 1940, Machinery Vibration Standards.
- From WHC-S-0424:
  - ASME N509-1989, Nuclear Power Plant Air Cleaning Units and Components,
  - Chapter 246-247 WAC, Radiation Protection – Air Emissions.
- From WHC-S-0434:
  - HANFORD Specification HS-V-P-4042, HEPA Element Procurement,
  - ASME N510, Testing of Nuclear Air Cleaning Systems,
  - ASME N509, Nuclear Power Plant Air Cleaning Units and Components,
  - ASME AG-1, Code on Nuclear Air and Gas Treatment.
- From WHC-S-0443:
  - National Electrical Manufacturers Association (NEMA), ICS 1-1993 General Requirements,
  - NEMA ICS 2-1993 Controllers, Contactors, and Overload Relays,
  - NEMA ICS 4-1993 Terminal Blocks,
  - NEMA ICS 6-1993 Enclosures,
  - National Fire Protection Association (NFPA) 70 (1993) National Electrical Code (NEC),
  - Underwriters Laboratories (UL) Electrical Appliance and Utilization Equipment

Directory 1994,

- o UL Electrical Construction Materials Directory 1994,
- o UL 508-1988 Industrial Control Equipment,
- o Factory Mutual System (FM) Approval Guide 1994.

Review of the documentation related to these system modifications indicates that the upgraded components maintained or enhanced the functional parameters of the annulus exhaust system. The modifications did not change system performance, and were not intended to meet new requirements. Additionally, the new components incorporated options to enhance operational reliability, maintainability and availability of spare parts. The new components were not intended to change the fit, form or function of the current system, and did not require procedure changes to the authorization basis. (USQ for WHC-S-0418, 424, 434 and 443). .

Drawing H-2-91982, Annulus Exhaust System Modifications, provides a good overall representation of demolition of the original components and installation of the upgraded system. This drawing was voided in 1995. The relevant information was incorporated into H-2-77326, Sheet 4 via ECN 706809.

The full set of drawings for the original 241-AY VTA system is listed on the Purex Tank Farm Expansion drawing index, H-2-64300, Rev. 7. Several of the key drawings that were reviewed are as follows:

- H-2-64460, "Annulus Vent Piping TK-102 241-AY Tank Farm." This drawing was voided in 1995.
- H-2-64462, "P&ID Tank 241-AY-102 Annulus." This drawing is partially superseded by drawing H-14-020206.
- H-2-64463, Ventilation Supply Equipment Plan and Details. This is the annulus inlet assembly. This drawing was voided in 1995.
- H-2-64464, HVAC Dehumidifier Installation Plans and Details. This drawing was voided in 1995.
- H-2-64465, Ventilation Exhaust Equipment Plan and Detail. This drawing was modified by H-2-91982, Exhaust System Modifications. Both of these drawings were voided in 1995. Relevant information from both drawings was incorporated into H-2-77326, Sheet 4 via ECN 706809.

In addition to the above drawings, the current system, including the modifications performed in the mid 1990's, as documented on the following partial set of system drawings were also reviewed (Reference ECN 706809):

- H-2-77324, "Annulus Vent Piping TK-102 241-AY Tank Farm,"
- H-2-77325, "Piping Sections TK-102 241-AY Tank Farm,"
- H-2-77326. "Piping Details TK-102 241-AY Tank Farm." Sheet 4 incorporates information from voided drawing H-2-91982 via ECN 706809.
- H-2-91069, "296-A-18 and 296-A-19 Record Sample Probes,"

- H-2-93373, "241-AY-101 Annulus Exhaust Stack Monitor Installation,"
- H-2-93374, "241-AY-102 Annulus Exhaust Stack Monitoring Installation",
- H-14-020206, "Ventilation Tank Annulus (VTA) O&M System P&ID."

APPENDIX D
REGULATORY, CODES, AND STANDARDS SUMMARY

In the early 1970s the Code of Federal Regulations (CFRs) were released. During the design phase of the 241-AY-102 VTA system these CFRs were not in existence. Prior to the 1970's, the continuous development of HEPA filters was being led by the United States Army. It was not until 1994 that these Military Specifications were incorporated into ASME AG-1. Radionuclide sampling techniques followed closely behind these developments. Table D1 – Summary of Important Dates for Nuclear Air Cleaning summarizes the timeline in the development of nuclear filtration.

Table D1 – Summary of Important Dates for Nuclear Air Cleaning

Year	Publication
1950	MIL-STD-282, *Filter Units, Protective Clothing, Gas-Mask Components and Related Products: Performance Test Methods*
1950	Stack Gas Committee
1950s	Arthur D. Little Co., *Fire Resistant Media*
1957	Air Cleaning Conference, "Filter Quality Problems"
1959	Air Cleaning Conference, "Filters Sent to Edgewood"
1959	Government/Industry Safety Committee
1959	UL-586, *High Efficiency, Particulate, Air Filter Units*
1961	High Efficiency Particulate Air Filter Units, TID 7023, Gilbert and Palmer
1962	Hanford (AEC/DOE) Filter Test Facility
1962	MIL-F-51068, *Filter, Particulates, High-Efficiency, Fire-Resistant*
1963	MIL-F-51079, *Filter Medium, Fire-Resistant, High-Efficiency*
1963	Flanders Inc. - Filter Media Production
1966	ORNL/NSIC-13, *Filters, Sorbets and Air Cleaning Systems as Engineered Safeguards in Nuclear Installations (Nuclear Air Cleaning Handbook, 1st Edition)*
1968	AACC CS-IT HEPA FILTER (IES), *Tentative Standard for HEPA Filters*
1968	ASHRAE 52.68, *Method of Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter*
1969	ANSI N13.1, *Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities*
1970	ORNL/NSIC-65, *Design, Construction, and Testing of High-Efficiency Air Filtration Systems for Nuclear Application*
1971	ANSI N-45.2, *Requirements for Quality Assurance Programs for Nuclear Power Plants*
1971	ANSI N-45.8 CONHET
1971	40 CFR 60, *Standards of Performance for New Stationary Sources*
1972	40 CFR 52, *Approval and Promulgation of Implementation Plans*
1972	Flanders Inc. - Manufactures Glass F-700 Media
1973	REGULATORY GUIDE 1.52, *Design, Testing, and Maintenance Criteria for Engineered Safety Feature Atmospheric Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants*
1973	REGULATORY GUIDE 3.12, *General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants*
1975	ANSI N510, *Testing of Nuclear Air Treatment Systems*
1976	ASME CONHET
1976	ANSI/ASME N509, *Nuclear Power Plant Air Cleaning Units*

Table D1 – Summary of Important Dates for Nuclear Air Cleaning

Year	Publication
1976	ERDA 76-21, *Nuclear Air Cleaning Handbook*, 3rd Edition
1978	Flanders Inc. – Manufactures Last Glass/Asbestos Media
1979	REGULATORY GUIDE 1.140, *Design, Inspection and Testing Criteria Air Filtration and Adsorption Units of Normal Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants*
1978	NE F3-41T, *In-Place Testing of HEPA Filter Systems by Single-Particle, Particle-Size Spectrometer Method*
1980	Flanders Inc. – Manufactures Last Asbestos Separators
1982	ANSI A-58.1, *Minimum Design Load in Buildings & Other Structures*
1984	DOE HEPA FILTER/TEST STANDARDS NE F3-43, -44, -45, *Nuclear Standards, Nuclear Standard Quality Assurance Testing of HEPA Filters, DOE Filter Test Facilities Quality Program Plan, and Specifications for HEPA Filters Used by DOE Contractors*
1984	NE F3-42, *Nuclear Standard, Operating Policy of DOE Filter Test Program*
1984	ASME AG-1, *Code on Nuclear Air and Gas Treatment*, 1st Edition
1988	ASCE 7, *Minimum Design Loads for Buildings and Other Structures*
1989	40 CFR 61, Subparts H & I, *National Emission Standards for Hazardous Air Pollutants*
1989	ASME NQA-1, *Quality Assurance Requirements for Nuclear Facility Applications*
1991	DOE/EH-0173T, *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance*
1991	WAC 246-247, *Radiation Protection – Air Emissions*
1993	ASTM-F-1471-93, *Standard Test Method for Air Cleaning Performance for HEPA Filter Systems*
1993	DOE O 5400.5 Chg. 2, *Radiation Protection of the Public and the Environment*
1997	DOE-STD-3020-97, Replaced NE F 3-45 HEPA Filter Standard, *Specification for HEPA Filters Used by DOE Contractors*
1999	ANSI/HPS N13.1, *Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities*
1999	ASHRAE 52.2, *Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size*
2003	ASME AG-1, *Code on Nuclear Air and Gas Treatment, Update*
2003	DOE Nuclear Air Cleaning Handbook, 4th Edition
2003	DOE-HDBK-1169, *Nuclear Air Cleaning Handbook*
2007	ANSI/ASME N511, *In-service Testing of Nuclear Air Treatment, Heating, Ventilating, and Air-Conditioning Systems*
2011	DOE O 458.1, *Radiation Protection of the Public and the Environment*

Table D2 – Codes and Standards Comparison Summary over the Life of 241-AY-102 shows the codes and standards that would have been in effect and have been considered for application to the 241-AY-102 VTA system at three major time frames in the life of the system. The first column expresses the overall type of code or standard. It should be noted that ANSI N13.1-1969 was published once construction on the VTA system had begun. This table is not an inclusive list.

Table D2 – Codes and Standards Comparison Summary Over the Life of 241-AY-102

Code/Standard Type	Codes and Standards 1971 (At construction)	Codes and Standards 1983 (At modification)	Codes and Standards 2013
Electrical	NFPA 70 - National Electrical Code (NEC)	NFPA 70 - National Electrical Code (NEC)	NFPA 70 - National Electrical Code (NEC)
Environmental		40 CFR 52 - Approval and Promulgation of Implementation Plans	40 CFR 52 - Approval and Promulgation of Implementation Plans
Environmental		40 CFR 60 - Standards of Performance for New Stationary Sources	40 CFR 60 - Standards of Performance for New Stationary Sources
Environmental		40 CFR 61 - National Emission Standards for Hazardous Air Pollutants	40 CFR 61 - National Emission Standards for Hazardous Air Pollutants
Environmental			WAC 173-480 - Ambient Air Quality Standards and Emission Limits for Radionuclides
Environmental			WAC 246-247 - Radiation Protection - Air Emissions
Environmental			DOE O 458.1 - Radiation Protection of the Public and the Environment
Environmental			DOE/EH-0173T - Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance
Environmental		National Environmental Policy Act of 1969 (NEPA)	National Environmental Policy Act of 1969 (NEPA)
Instrumentation		ANSI/IEEE N42.18 - Specification and Performance of On-Site Instrumentation for Continuously Monitoring Radioactivity in Effluents	ANSI/IEEE N42.18 - Specification and Performance of On-Site Instrumentation for Continuously Monitoring Radioactivity in Effluents
Nuclear Ventilation	ORNL/NSIC-65, Design, Construction, and Testing of High-Efficiency Air Filtration Systems for Nuclear Application	ERDA 76-21, Nuclear Air Cleaning Handbook, 3rd Edition	DOE-HDBK-1169-2003 - Nuclear Air Cleaning Handbook
Nuclear Ventilation	AACC CS-IT HEPA FILTER (IES), Tentative Standard for HEPA Filters	AACC CS-IT HEPA FILTER (IES), Tentative Standard for HEPA Filters	ASME AG-1 2009 - Code of Nuclear Air and Gas Treatment

Table D2 – Codes and Standards Comparison Summary Over the Life of 241-AY-102

Code/Standard Type	Codes and Standards 1971 (At construction)	Codes and Standards 1983 (At modification)	Codes and Standards 2013
Nuclear Ventilation	ANSI N13.1 1969 - Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities	ANSI N13.1 1969 - Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities	ANSI/HPS N13.1 1999 - Sampling and Monitoring Releases of Airborne Radioactive Substances From the Stacks and Ducts of Nuclear Facilities
Nuclear Ventilation		ANSI/ASME N509 - Nuclear Power Plant Air-Cleaning Units and Components	ANSI/ASME N509 - Nuclear Power Plant Air-Cleaning Units and Components
Nuclear Ventilation		ANSI/ASME N510 - Testing of Nuclear Air Treatment Systems	ANSI/ASME N510 - Testing of Nuclear Air Treatment Systems
Quality Assurance		ANSI N45.2 – Quality Assurance Program Requirements for Nuclear	ANSI/ASME NQA-1 Quality Assurance Program Requirements for Nuclear Facilities
Nuclear Seismic			ANS 2.26 - Categorization of Nuclear Facility Structures, Systems, and Components for Seismic Design
Structural		ANSI A58.1 – Minimum Design Load in Buildings & Other Structures	ASCE 7 - Minimum Design Loads of Buildings and Other Structures

***Note: In general, the DOE orders reference several consensus or other national codes and standards for consideration in the design. Not all codes and standards referenced in the DOE orders apply to the 241-AY-102 VTA. Except where otherwise noted within this document, application of the codes and standards called out by the orders is not specifically documented for the VTA system.

The 241-AY-102 VTA system upgrades have essentially updated all components of the system except for the stack and the inactive heater. Therefore, it is assumed that the majority of the VTA system, with exception of the stack and the inactive heater, were designed and constructed in accordance with a code or standard that is still in effect today as shown in Table D2. In general the majority of the codes and standards applied from 1983 through present (2013) have not been superseded by a new code or standard or cancelled. Most of the codes and standards shown in Table D2 have been revised or updated to reflect changes in the requirements, but not a change in the purpose. The focus will be placed upon those codes or standards that have been fully superseded.

ERDA 76-21 has been superseded by DOE-HDBK-1169-2003. The Nuclear Air Cleaning Handbook was originally ORNL/NSIC-65 and has been shifted from one organization to another and is now with DOE. These changes were simply revisions for updated requirements and ownership. ANSI N45.2 was superseded by ASME NQA-1 for Nuclear Quality Assurance. ANSI A58.1 was superseded by ASCE 7 for general building and structural requirements. Upon review, the general scope of these codes and standards has remained the same regardless if they have been superseded or revised.

Attachment 2
13-ECD-0054
(38 Pages)

ANSI/HPS N13.1 Compliance Matrix for
Stack 296-A-19 at 241-AY-102

Dennis W. Bowser

ANSI/HPS N13.1 COMPLIANCE MATRIX FOR STACK 296-A-19 AT 241-AY-102

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Key Words: 241-AY-102, Annulus Ventilation, VTA, 241-AY, Sampling, Monitoring, Compliance Matrix, ANSI N13.1, ANSI/HPS

Abstract: This report reviews compliance of the existing AY-102 annulus exhaust ventilation system sampling and monitoring system with ANSI/HPS N13.1-1999. This report is in response to the Washington Department of Health revised Notice of Construction (NOC-877) for the 296-A-19 actively ventilated stack for the AY-102 annulus ventilation system

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ANSI/HPS N13.1 COMPLIANCE MATRIX FOR STACK 296-A-19 AT 241-AY-102

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VISTA ENGINEERING TECHNOLOGIES

Report Title:	**ANSI/HPS N13.1 COMPLIANCE MATRIX FOR STACK 296-A-19 AT 241-AY-102**
Project Title:	**241-AY-102 Annulus Exhauster Ventilation System Sampling and Monitoring System Evaluation**
Status:	☐ **In-Process** ☒ **Final**

Revision History

Revision #	Reason for Revision	Approvals/Date
0	Initial Release	Originator: R. Mitchell 6/5/2013 Checker: J. Kriskovich 6/5/13 PM: M. Vosk 6/5/13 Other:

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1.0 INTRODUCTION

The 241-AY-102 Ventilation Tank Annulus (VTA) System Stack 296-A-19 at Hanford Site tank farms is a key part of the Ventilation Tank Annulus System. The stack was originally designed and constructed without a record sampler. The record sampler is used to take samples that are collected for reporting purposes and are analyzed off-line. A sampler was designed and installed in the mid-1980s to ANSI N13.1-1969, *Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities*. Stack emissions effluent sampling and monitoring system of new or modified sources must comply with ANSI/HPS N13.1-1999, *Sampling and Monitoring Releases of Airborne Radioactive Substances From the Stacks and Ducts of Nuclear Facilities*, as required by Title 40, *Code of Federal Regulations*, Part 61, "National Emission Standards for Hazardous Air Pollutants," Section 93 (40 CFR 61.93). The Washington State Department of Health (WDOH) in a letter (Air 13-401, NOC 877) submitted to Washington River Protection Solutions (WRPS) requested an evaluation of compliance with ANSI/HPS N13.1-1999. This report demonstrates partial compliance with the ANSI/HPS N13.1-1999 standard.

The 241-AY-102 VTA system stack (296-A-19) modifications were designed in accordance with ANSI N13.1-1969. RPP-11595 confirmed compliance with the 1969 version of the standard for the record sampling system from the nozzle to the sample holder. Significant changes were made to the standard when it was revised in 1999. The revised standard provides specific performance criteria and the requirements for various air sampling processes. A graded approach to sampling is recommended with a more stringent approach for the stacks with a greater potential to emit. An additional calculation, RPP-CALC-55212, was written in response to the WDOH letter (Air 13-401, NOC 877) to verify the deposition requirements of the 1999 version of the standard.

2.0 SCOPE

The scope of this report is to determine if the 241-AY-102 VTA System Stack 296-A-19 Sampling System complies with the requirements set forth by ANSI/HPS N13.1-1999.

3.0 LIMITATIONS

The attached matrix covers the existing system design. A fence line field walk-down was completed. Access was restricted to the project team due to the requirements in the radiological work permit (unescorted) selected for use. However, WRPS has provided sufficient documentation, drawings, pictures, and video of the inspection to perform a desk evaluation.

4.0 METHOD

The ANSI/HPS N13.1-1999 standard contains a number of requirements and recommendations for sampling and monitoring releases of radioactive substances from the ventilation stacks of nuclear facilities. A review of the standard was conducted and the requirements and recommendations are extracted and listed as items in a three-column matrix (See Appendix A). The section number for the requirement is listed in the left column along with a brief description of the requirement. The middle column shows whether the requirement is satisfied or not. If the requirement is satisfied, *Yes* is listed. If the requirement is not satisfied, *No* is listed. If the requirement does not apply, *N/A* is listed. Finally the right column contains a brief explanation along with supporting documentation of how the requirement is met.

It should be noted that requirements and recommendations are usually identified with "shall" and "should" statements respectively. The term "should" denotes a recommendation, good management practice, or a desirable action in order to meet the intent of the standard. Several of these recommendations have been reviewed and even if the recommendation is met, it is marked *N/A*.

5.0 CONCLUSION

The Sampling System for Stack 296-A-19 at the 241-AY-102 VTA System was designed in accordance with ANSI N13.1-1969 and verified via RPP-11595. Due to the significant changes and performance criteria requirements in the 1999 version, as opposed to the 1969 version, of the standard, stack 296-A-19 would not fully comply with ANSI/HPS N13.1-1999. Maintenance, calibration, and field check requirements that were not performed are shown in Table 1 – ANSI/HPS N13.1-1999 Maintenance, Calibration, and Field Check Requirements. In general, dedicated procedures were not found for inspection and maintenance of the sampling probe nozzles. Nevertheless, overall compliance for maintenance, calibration, and inspections is acceptable.

System performance criteria that would not meet the 1999 standard are shown in Table 2 – ANSI/HPS N13.1-1999 Performance Criteria. Areas where the current system would not meet the criteria for performance are generally related to the absence of testing or computer analysis to ensure that the sampling location and design meet all requirements.

Assuming the stack would pass the testing requirements, design, inspection, and maintenance changes could be engineered into the current stack at 241-AY-102 to allow for potential full compliance with ANSI/HPS N13.1-1999. These changes would consist of the following:

- Continuous recording of sample and stack flow (includes continuous air monitoring)
- Verification of sampling location and design via tracer testing or computer analysis (computational fluid dynamics)
- Maintenance and inspection procedures updated to reflect all necessary requirements

Note: An additional review of compliance would be needed if these changes were performed.

Table 1 - ANSI/HPS N13.1-1999 Maintenance, Calibration, and Field Check Requirements

(Table 5 from ANSI/HPS N13.1-1999)				
Item	**Description**	**Frequency**	**ANSI N13.1 Reference**	**Compliance**
1	Cleaning of the thermal anemometer elements	As required by application	6.2.2.1	No thermal anemometers
2	Inspect pitot tubes for contaminant deposits	At least annually	6.2.2.2	No pitot tubes. 3-VBP-155 would be used for inspection.
3	Inspect pitot tube systems for leaks	At least annually	6.2.2.2	No pitot tubes. 3-VBP-155 would be used for inspection.
4	Inspect sharp-edged nozzles for damage	At least annually or after maintenance	6.3.4.5	Annual inspections are not driven procedurally. An inspection was completed May 2013.
5	Check nozzles for alignment, presence of deposits, or other potentially degrading factors	Annually	6.3.4.8	Annual inspections are not driven procedurally. An inspection was completed May 2013.
6	Check transport lines of HEPA-filtered applications to determine if cleaning is required	Annually	6.4.6	Annual inspections are not driven procedurally. An inspection was completed May 2013.
7	Clean transport lines	Visible deposits for HEPA filtered applications	6.4.6	Annual inspections are not driven procedurally. An inspection was completed May 2013. Transport line cleaning is not required if visible deposits are not seen inside the sample probe nozzle (Letter 03-ESD-141)
8	Inspect or test the sample transport system for leaks	At least annually	6.9	Annual inspections are not driven procedurally. An inspection was completed May 2013.
9	Check mass flow meters of sampling systems with a secondary or transfer standard	At least quarterly	7.5.1	No mass flow rate instrumentation is installed.
10	Check sampling flow rate through critical flow venturis	Start of each sampling period	7.5.1	No critical flow venturis
11	Inspect rotameters of sampling systems for presence of foreign matter	Start of each sampling period	7.5.1	TF-OPS-006
12	Check response of stack flow rate systems	At least quarterly	7.5.2	6-FCD-077
13	Calibration of flow meters of sampling system	At least annually	7.6.1	Preventative maintenance package ET-02386

(Table 5 from ANSI/HPS N13.1-1999)				
Item	**Description**	**Frequency**	**ANSI N13.1 Reference**	**Compliance**
14	Calibration of effluent flow measurement devices	At least annually	7.6.2	Preventative maintenance package ET-05944
15	Calibration of timing devices	At least annually	7.6.3	Preventative maintenance package ET-04841

Table 2 - ANSI/HPS N13.1-1999 Performance Criteria

(Table 6 from ANSI/HPS N13.1-1999)			
Item	**Performance Criterion**	**ANSI N13.1 Reference**	**Compliance**
1	Total transport of 10 μm AD particles and vaporous contaminants shall be >50% from the free stream to the collector/analyzer	6.4.1 6.5	RPP-CALC-55212
2	Sampler nozzle inlet shall have a transmission ratio between 80% and 130% for 10 μm AD particles	6.3.2	RPP-CALC-55212
3	Sampler nozzle shall have an aspiration ratio that does not exceed 150% for 10 μm AD particles	6.3.2	RPP-CALC-55212 Assumed to be 100%
4	Sampling location coefficient of variation over the central 2/3 area of the cross section is within +/-20% for 10 μm AD particles, gaseous tracer, and gas velocity	5.2.2.2	No testing has been completed to verify.
5	Sampling location flow angle <20 degrees relative to the long axis of the stack and nozzle inlet	5.2.2.2	No testing has been completed to verify.
6	Sampling location tracer gas concentration shall not vary from the mean >30% at any point on a 40 CFR 60 Appendix A Method 1 velocity mapping grid	5.2.2.2	No testing has been completed to verify.
7	Effluent flow rate continuous measurement required if flow variation is >+/-20% in a year	6.2.1	No continuous flow measurements are currently utilized.
8	Effluent and sample flow rate shall be measured within +/-10%	6.2.1 7.6.1	Sample flow rates use ET-02386. Effluent flow rate is currently not being measured.
9	Continuous sample flow rate measurement and control required if flow varies >+/-20% during a sample interval. Flow control shall be within 15%.	6.8.2 6.8.3	No continuous flow measurements are currently utilized.
10	Continuous measurement of effluent flow rate and continuous measurement and control of sampling flow rate for stacks where significant emissions could occur (PIC 1)	6.2.1 6.8.1 6.8.3	No continuous monitoring.

(Table 6 from ANSI/HPS N13.1-1999)			
Item	**Performance Criterion**	**ANSI N13.1 Reference**	**Compliance**
11	Maintain ratio between sample flow rate and effluent flow rate within 20% of predetermined value (PIC 2)	6.2.1	Effluent flow is not currently monitored.
12	Periodic inspection of nozzles, transport lines, sample and effluent flow meters shall be conducted	7.5	Annual inspections are not driven procedurally. An inspection was completed May 2013.
13	Periodic calibrations of effluent and sample flow meters, CAMs, and sample analysis instrumentation shall be conducted	7.6	Sample flow meters are calibrated via ET-02386. Effluent flow rate is currently not being measured. No CAM is installed. TFC-OPS-MAIN-C-07 requires all calibration to be traceable to NIST.

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Attachment A – ANSI/HPS N13.1-1999 Compliance Matrix

ANSI/HPS N13.1-1999 Clause 4 – Objectives and Approaches for Sampling Programs		
Requirement	**Satisfied**	**Compliance**
4.1 – Defining the sampling objective: The rationale for choosing a specific sampling objective and approach shall be documented.	Yes	A radioactive air emissions report is required by WAC 246-247-080. TFC-PLN-71 is the QA program plan for Tank Farm Contractor Radioactive Air Emissions.
4.2 - Developing a graded approach to sampling:	N/A	Title/Heading only
4.2.1 – Estimating potential emission: A survey shall be conducted of the potential sources of radionuclide emissions at a facility to determine the following: (1) the form and radiological inventory of materials being handled, (2) the potential extent of airborne dispersal of this inventory and resultant concentrations at the facility boundary in the event of accidental loss of filtration and control of stack emissions, (3) the potential effective dose equivalent that would be received by a member of the public if such a release occurs, and (4) a comparison of potential doses to appropriate regulatory limits.	No	The PTE was estimated as documented in the CY2013 permit modification application, DOE letter 13-ECD-0012 dated 3/7/2013. The original potential emissions were not considered.
4.2.2 – A graded approach to sampling: A graded approach to establishing a sampling and monitoring program should also be undertaken.	Yes	RPP-11595 was written to determine the adequacy of the current probes used to monitor the annulus at exhaust stacks at AY/AZ including 296-A-19. These sample probes were designed and installed in accordance with ANSI N 13.1-1969 and other applicable guidance. Recommended Stack probe position, sample nozzle locations, probe bend radius, near isokinetic sampling, and minimization of particle deposition have all been incorporated in the design, indicating that the probes are adequate for the purposes to which they are applied. RPP-CALC-55212 verifies the results of the sampling probes.

4.3 - Consideration for different sampling situations: Particular attention should be given to the potential interactions between the operating conditions of the facility, the airborne contaminants, the ventilation components, and the sampling system.	N/A	Recommendation only.
4.3.1 – Considerations for sampling normal and off-normal conditions: A sampling system should be designed to accommodate both normal and off-normal operating conditions.	N/A	Recommendation only.
4.3.2 – Sampling for aerosol particles: Consideration should be given to sampling aerosol particles.	N/A	Recommendation only. RPP-11595 and RPP-CALC-55212 ensure that the sampling of aerosol particles is completed efficiently.
4.3.3 - Concerns for large particles: Consideration should be given to aerosol particles much larger than 10 μm AD by installing a special sampling apparatus in the duct near the process	N/A	Not a requirement. No other sampling techniques are utilized at stack 296-A-19 other than that of the record sampler.
4.3.4 - Sampling condensable vapors or reactive gases: Consideration should be given to sampling radioactive air contaminants in the form of condensable vapors and reactive gases.	N/A	Recommendation only.
4.3.5 – Sampling non-condensable, nonreactive gases: Consideration should be given to sampling radioactive air contaminants in the form of non-condensable, non-reactive gases.	N/A	Recommendation only.
4.4 – Determining action levels: Action levels required for the air sampling system and program shall be considered as part of the design basis. It is useful in the context of discussing action levels to draw distinctions among the following: (a) Control monitoring (b) System availability (c) Performance sampling	N/A	Recommendation only. No information could be retrieved regarding original action levels that would signal a significant changing condition. The stack would be subject to any sampling action levels come from WAC 246-247 if it were to comply with ANSI/HPSN13.1-1999.
4.4.1 - Action levels for control monitoring: Continuous air monitor (CAM) correctly designed with appropriate installation location.	No	No continuous air monitoring (CAM) device is used on the 241-AY-102 stack 296-A-19. There is a CAM used in the tank leak detection system.
4.4.2 Action levels for record sampling: If elevated concentrations of radioactive contaminants could be present in the effluent stream of high hazard stacks (PIC 1) there shall be control monitoring. However, any stack that has the potential for radioactive emissions (PIC 1-3) should have record sampling at an appropriate frequency.	Yes	Sampling action levels are stated in WAC 246-247 and RPP-16922.

4.4.3 System sensitivity needed to achieve selected action levels: The proposed sampling or monitoring system shall be sufficiently sensitive (at the 95% confidence level).	Yes	RPP-11595 analyzes the overall efficiency of the sampling probes in 296-A-19. It is recommended that a tracer test be completed on the stack sampling system to ensure that overall deposition is up to the 50% requirement.
4.4.4 System performance and availability alarms: System performance and availability alarms are a separate consideration from action levels based on effluent releases. The sampling system designer shall consider the need for alarms activated by system component failure that results in the inability to properly sample. System failures can take two forms: Complete failure and partial failure.	Yes	RPP-15128, Table 4, contains the AY/AZ Tank Farms Ventilation Tank Annulus System Alarms.
ANSI/HPS N13.1-1999 Clause 5 – Sampling Locations		
Requirement	**Status**	**Compliance**
5.1 – Characterizing the sampling environment: The sampling environment within a stack or duct shall be characterized to design the sampling system for those conditions.	Yes	Ductwork is stainless steel or protection-coated carbon steel. Filter plenums are stainless steel and instruments are designed for use outdoors. Some instruments are located within electrical cabinets that are rated for outdoor use. No document has been found that provides evidence that the VTA systems were designed to withstand the stated environmental conditions. The VTA systems have been operational for over 20 years. (RPP-15128 Section 3.5.5)
5.1.1 - Temperature: The expected temperature range at potential sampling points under normal operating conditions and credible accident conditions should be determined.	Yes	RPP-11413 has a maximum stack temperature of 122°F. Based on the AMS-4 CAM temperature limit. It should be noted that stack 296-A-19 does not have a CAM.
5.1.2 - Effluent flow rate: Knowledge of effluent flow rate is important in any final calculation of a release rate or a total release.	Yes	Stack flow measurements are characterized via 3-VBP-155, *Air Flow Test for Tank Farm Stacks and Ducts*, in conjunction with locations specific data sheets.
5.1.3 - Duct geometry: Duct geometry, including shape, main stack flow inlet conditions, additional lateral entry of contaminated flows, orientation of stack elements with respect to the vertical, and the presence or absence of such flow disturbance elements as bends can be important factors in the design of proper sampling systems and their locations in the stack. The stack and duct geometry information shall be fully documented.	Yes	RPP-15128, Appendix B, contains a list of drawings and documents that fully defined the duct geometry of stack 296-A-19 at 241-AY-102.

5.1.4 - Effluent composition: The composition of a stack effluent under both normal and accidental conditions shall be taken into account when the design of a sampling system for the stack is developed.	Yes	10 micron, non-condensable effluent stream is analyzed in RPP-CALC-55212. The WDOH license (AIR 13-401 NOC 877) states that total Alpha and total Beta are to be measured.
5.1.5 - Particle size: The efficiency of extracting, transporting, and collecting sampled particles is sensitive to the size (AD) of the contaminant-bearing particles.	Yes	RPP-11595 deposition was completed using a particle diameter of 10 μm. Additionally, RPP-CALC-55212 verifies these results.
5.2 - Selection of sampling sites	N/A	Title/Heading only
5.2.1 - General considerations: Locating a site in a stack or duct where a representative sample can be obtained by extractive methods involves such considerations as the characteristics of the radioactive contaminant, factors associated with equipment placement and support, and worker health and safety. If the contaminants are in the form of condensable vapors or reactive gases, long transport lines and large temperature changes in the sample or the transport line shall either be avoided or measures shall be taken to minimize potential loss of sample.	Yes	RPP-11595 determined 296-A-19 to be adequately compliant with ANSI N13.1-1969 for sampling (location, geometry, etc.). RPP-CALC-55212 verifies the results of the record sampling requirements. H-14-020206 Sheet 3 illustrates these ports for 296-A-19 stack at 241-AY-102.
5.2.2 - Qualifying the sample extraction location: The site shall be chosen to provide a valid representative sample of the entire contaminant discharge.	Yes	RPP-11595 evaluates the stack probe position and sample nozzle locations as adequate for the purposes to which they are applied. RPP-CALC-55212 verifies the results of the record sampling requirements.
5.2.2.1 – Angular or cyclonic flow: The flow angle at the extraction point shall be verified to be less than 20 degrees from the flow axis. If there is excessive flow swirl (cyclonic flow), it can be corrected by using internal elements placed in the stack or duct.	No	No testing was completed to ensure this requirement is met. Additional testing or computer analysis would be needed to fully comply with this requirement.
5.2.2.2 – Contaminant concentration and velocity profile: (a) The coefficient of variation (COV) of concentration of 10 ±1 μm AD tracer aerosol particles and a tracer gas shall be less than or equal to 20% across the center 2/3 cross-sectional area of the stack. (b) The COV of the stack gas velocity shall be within ±20% across the center 2/3 of the stack. (c) If only gaseous contaminants can be present, an additional criterion beyond that for aerosol particles must be met. At no point in a complete grid for velocity setup in accordance with 40 CFR 60, Appendix A, Method 1, shall the concentration of tracer gas be any higher than 30% above the mean concentration value in that sampling plane.	No	No testing was completed to ensure this requirement is met. Additional testing or computer analysis would be needed to fully comply with this requirement.

5.3 – Methods for qualifying the sample extraction location: (a) The tests for qualifying the sample extraction location for gas mixing should introduce the tracer gas at five or more locations across the air stream (At the center and near each corner). (b) The degree of mixing for aerosols shall be tested with 10 ± 1 μm AD particles. (c) Sampling of the tracer gas shall be conducted across the cross-sectional plane at the proposed sampling location. (d) The aerosol may be introduced at one point downstream of feeder ducts, fans, and control equipment.	No	No testing was completed to ensure this requirement is met. Additional testing or computer analysis would be needed to fully comply with this requirement.
5.4 - Sampling locations other than final effluent streams: Sampling may be required at locations upstream of the final exhaust discharge point for purposes of observing process conditions, personnel protection, or aiding the interpretation of measurements of the final exhaust. The sampling performance criteria for these locations may be the same as for normal final exhaust sampling.	N/A	Stack 296-A-19 only has the record sampling capability. CAM would be needed to fully comply with this requirement.

5.5 – Designing effluent discharge systems for sampler placement: The sampling system design shall include provisions for extracting a representative sample and for transport and collection equipment that ensures minimal loss (wall deposition) of contaminants in the transport and collection of the sample. The most important requirement for extracting a representative sample is that the sampling plane shall be located where the effluent is well mixed. (a) Do not add another effluent discharge point to the stream beyond the sampling location; (b) Do not locate the sampling location upstream of any effluent attenuation devices; (c) Include a section upstream of the sampling plane where corrective devices such as mixing elements could be easily installed; (d) Locate the sampling plane downstream of devices that promote mixing of the contaminants; (e) Avoid the use of flow straighteners except after the contaminants are well mixed and only to remedy angular or cyclonic flow. (f) Locate the sampling plane close to the collector or analyzer to ensure that transport lines are short and have few bends and transitions; (g) Provide ample access to service and maintain the sampling system and to install any needed shielding; (h) Provide for a stable electrical supply, environmental conditioning, and low levels or vibration; (i) Provide ample access ports for visual inspection of the nozzle, flow transmitter verification, and sampler performance testing.	No	The stack contains a record sampler with an associated EDP code of E061. It contains (1) probe and (3) separate nozzles. The probe location is approximately 1/2 duct diameters below the top of the stack and 9 & 2/3 duct diameters above the expansion section of the stack above the fan discharge entry point. (WHC-SD-WM-ES-291 Appendix C35) Stack 296-A-19 was built to the requirements of ANSI N13.1-1969. However, no testing or computer analysis has been completed to ensure that sampler is located in the correct location within the stack.

ANSI/HPS N13.1-1999 Clause 6 – Sampling System Design

Requirement	Status	Compliance
6.1 – Sample flow rate: In general, continuous extractive sampling systems for collection of particulate matter will typically operate at flow rates of 25 to 100 L min^{-1} while those for gases will operate in the range 0.1 to 100 L min^{-1}.	Yes	RPP-CALC-55212 demonstrated a flow rate of 56.6 L/min or ~2.0 CFM

6.2 - Bulk stream volumetric flow measurement: The flow rate of air exhausted through a stack or duct shall be periodically measured and may need to be continuously monitored if there is a potential for significant emissions.	No	The volumetric flow rate is measured via TF-OPS-005. No CAM is being utilized.
6.2.1 – Requirements: (a) PIC 1 - Stacks that may potentially emit more than 50% of the allowable annual dose shall be continuously measured. PIC 2 - Stacks that may potentially emit between 1% and 50% of the allowable annual dose shall be continuously measured if the flow rate is anticipated to vary by more than 20% during the year. PIC 3 - Stacks that may potentially emit between 0.01% and 1% of the allowable annual dose shall only have period measurements of flow rate. (b) For stacks that are continuously measured, the stack flow measurement and recording system shall be capable of determining the mass flow rate of the effluent stream within 10% of a that measured by the Reference Method (40 CFR 60, Appendix A, Methods 1 and 2). (c) The flow measurement device shall be audited for accuracy annually.	No	No continuous mass flow rate instrumentation is installed.
6.2.2 - Apparatus and applications:	N/A	Title/Heading only
6.2.2.1 - Thermal anemometers: When a single point anemometer is used, a correction factor shall be established to relate average mass flow rate to the reading from the single thermal anemometer element.	N/A	Thermal anemometers are not used on stack 296-A-19
6.2.2.2 – Pitot tubes: Pitot tubes shall be inspected annually for deposits and tested annually for leaks. Leakage at average flow conditions shall not affect the results of differential pressure by more than 1%.	N/A	No pitot tubes are used for continuous flow measurements on this stack.

6.2.2.3 - Acoustic flow meters: If acoustic flow meters are used a correction factor shall be established between the reading of the instrument and the volumetric flow rate through the stack.	N/A	Acoustic flow meters are not used on stack 296-A-19.
6.3 - Nozzle design and operation for sampling aerosol particles:	N/A	Title/Heading only
6.3.1 - Basic considerations: In place of multiple point sampling, single point representative sampling should be used, with the requirement that both fluid momentum and contaminant mass are well mixed at sample extraction location in the sampling plane as specified in the performance criteria of clause 5.2.2.2.	No	No testing has been completed to ensure this requirement is met.
6.3.2 – Nozzle performance: (a) Sampling nozzles used for particulate sampling shall have an aerosol transmission ratio within the range of 0.80 to 1.30 and an aspiration ratio within the range of 0.80 to 1.50 for 10 μm particles or the range of sizes that could be encountered in normal operating conditions (if larger than 10 μm) over the operating range. (b) Compliance shall be demonstrated with liquid aerosol particles	Yes	RPP-CALC-55212 – Isokinetic transmission ratio is 0.90, anisokinetic transmission ratio is 1.09, and the aspiration ratio is assumed to be 1.0.
6.3.3 - Nozzle designs: The presence of a nozzle should not disturb the aerosol concentration in the stack or duct. Accordingly, the frontal area of a nozzle should not be greater than 15% of the stack or duct cross sectional area.	Yes	Recommendation only. From H-2-77326 Sheet 5 The stack has an ID of 15 in. Cross-sectional area for the stack = A1 = π*(15 in /2)^2 = 176.7 in^2 From H-2-91069 The nozzles have an OD of 0.5 in. Cross-sectional area for each nozzle = A2 = π*(0.5 in /2)^2 = 0.196 in^2 A2* = 3*A2 = 0.588 in^2 A2* is less than 15% of A1.
6.3.4 - Application and performance considerations: The following factors should be considered in the selection and use of a sampling nozzle.	N/A	Title/Heading only
6.3.4.1 – Location: Sampling should take place at a location where both the aerosol concentration and fluid momentum are well mixed.	N/A	Recommendation only. No testing or computer analysis was completed to ensure that the aerosol concentration

		and fluid momentum are well mixed at the current sampling location.
6.3.4.2 – Orientation: For aerosol sampling, the nozzle should be aligned parallel to the flow.	N/A	Recommendation only. The nozzle orientation is parallel to flow as shown on H-2-92970 Sheet 1.
6.3.4.3 – Transmission and aspiration ratios: (a) The transmission and aspiration ratios shall be traceable to experimental verification of performance for conditions that include that nominal sampling flow rate and range of anticipated sampling flow rates, the nominal free stream velocity and the range of anticipated free stream velocities, and a particle size of 10 µm AD. (b)If actual testing is used, the means for determining the transmission and wall loss ratios shall be documented. If reference to previous testing is employed, the equivalency of the selected design and the design that was tested shall be documented.	No	RPP-11595, which analyzes the sampling probes, is the only documentation that reviews the capability of the design. RPP-CALC-55212 confirms these deposition results. Additional testing or computer analysis would be needed to fully meet this requirement.
6.3.4.4 – Sampling flow rate and free stream velocity: The flow rate of a stack with the potential to emit greater than 50% of the allowable annual dose shall be varied in proportion to the flow rate through the stack. The maximum variation in the flow rate ratio is ±25%.	Yes	The record sampler vacuum pump for each VTA system is interlocked with the exhaust fans to operate only when an exhaust fan is operating. This ensures accurate sampling of particulate radionuclides in the exhaust air stream. A relay in the motor control center for the exhaust fans is wired to a switched outlet in the record sampler enclosure. (RPP-15128, Section 4.1.6)
6.3.4.5 – Nozzle configuration: (a) The leading edge of the nozzle should have a sharp edge with the external cone angle not to exceed 30°. If shrouded, the shroud should not have a sharp edge. (b) The leading edge of sharp edged nozzles should be inspected for damage following installation and subsequent to any maintenance procedures in which the nozzle could be damaged.	N/A	Recommendation only. H-2-91069 documents the probe design. Additionally, TFC-WO-13-2168 inspected the nozzles in stack 296-A-19.

6.3.4.6 - Rakes: While the use of a sampling rake is discouraged, if one is to be used it shall be tested for aerosol transmission. (a) Each of the nozzles shall meet the requirements contained in clause 6.3.2. (b) If all nozzles on the rake are identical and a nozzle can be separated from the rake, tests may be conducted on a single nozzle; otherwise, tests shall be conducted with the nozzles mounted on the rake and the rake shall meet the criteria in clause 6.3.2. (c) Flow rate through each nozzle in a rake, or the velocity at the inlet plane of each nozzle in a rake, shall be measured by a method that does not affect the flow through other nozzles in the rake. (d) Flow rate or inlet-plane velocity measurements may be conducted with the rake removed from the stack or duct. (e) The flow rate or inlet-plane velocity of any nozzle may not differ from the mean flow rate by more than ±10%. (f) The transmission of an aerosol through a rake shall be measured or calculated and documented.	Yes	The design at 241-AY-102 stack 296-A-19 utilizes a sampling rake style design. RPP-11595 analyzes the sampling probes used in stack 296-A-19. The results show that the stack adequately meets ANSI N13.1-1969 requirements. RPP-CALC-55212 confirms that the requirements for record sampling deposition are met.
6.3.4.7 – Materials of construction: (a) The nozzle shall be constructed of materials that will not react with the aerosols or vapors in the effluent stream. (b) The surface roughness of the internal regions of the nozzle should not exceed 0.8 µm and the average surface roughness of the external region of the sampling nozzle from the inlet plane to a distance of two nozzle inlet diameters from the inlet plane should not exceed 1.6 µm. (c) A shroud should have an average surface roughness that does not exceed 3.2 µm.	Yes	No information exists on the roughness of the sampling probes other than the nozzles are constructed of 300 series stainless steel. (H-2-91069) The requirement is met due to only (a) containing "shall"
6.3.4.8 – Maintenance: The sampling nozzle shall be checked annually for alignment, presence of deposits of foreign materials, and other factors that could degrade the performance of the sampling system.	No	The record sampler system is tested and calibrated annually for the following: Sampler Loop calibrations, Sample probe and transport line for particle buildup and integrity inspection, Sample flow rate controller functional test and calibration, Sample flow rate indicating device functional test and calibration

		Timing device calibration (RPP-16922, Section 2.3.1) TFC-WO-13-2168 performed an inspection of the AY-102 VTA record sample line leading from the record sample cabinet up the exhaust stack to the record sample probe. Annual inspections of the nozzles are currently not driven procedurally.
6.3.4.9 - New concepts: When new approaches are developed for design and operation of nozzles, such designs may be used in ducts and stacks if it can be demonstrated experimentally that the designs meet, or exceed, the performance specifications given in clause 6.3.2.	Yes	The design at 241-AY-102 stack 296-A-19 utilizes a sampling rake style design with collection of all probes at a compression fitting. RPP-11595 analyzes the sampling probes used in stack 296-A-19. The results show that the stack adequately meets ANSI N13.1-1969 requirements.
6.4 Sample transport for particles: The transport of aerosol particles from a sampling nozzle to a collector or analyzer shall take place in such a manner that changes in concentration and size distribution of airborne radioactive materials are minimized within the constraints of the current technology.	Yes	RPP-11595 analyzes the sample transport line, which is approximately 9 feet long from the probe connection outside of the stack to the top of the sample cabinet. The tubing is 3/4 O.D. X 0.035 WALL. There are (2) 45 degree bends. The designed bend radius is 10 times the diameter. (*WHC-SD-WM-ES-291 Appendix C6*) RPP-CALC-55212 re-analyzed the transport tube in the approximate geometry that was found in the field. One 90 degree bend in place of the (2) 45 degree bends.
6.4.1 – Depositional losses: The deposition losses of particles inside the transport tubing shall be evaluated via experimental techniques, through use of documented computer codes or through use of documented and referenced hand calculations for either 10 μm AD aerosol particles or the size range expected in the particular application under normal, off-normal, and anticipated accident conditions. The total penetration of 10 μm particles from the free stream to the collector or analyzer should not be less than 50%.	Yes	RPP-11595 evaluates the deposition losses of particles inside the transport tubing using computer modeling. RPP-CALC-55212 confirms these findings.

6.4.2 – Corrosion: (a) The internal walls of the transport systems shall be constructed of materials that are minimally reactive to inadvertently deposited aerosol particles or to reactive vaporous compounds that could be present in the sample. (b) The materials of construction for external walls and seals between sampling system components should also be compatible with the environment to which they are exposed.	Yes	All transport system materials in contact with the effluent stream and the environment are made of stainless steel. (H-2-93374 Sheet 1)
6.4.3 – Electrostatic effects and flexible tubes: Transport system should be constructed of materials such as metals or conductive plastic that will not sustain internal electrostatic fields.	N/A	Recommendation only. The transport system is constructed of 300 series stainless steel (metal). (H-2-93374 Sheet 1)
6.4.4 – Smoothness of internal surfaces: The internal surfaces of transport lines should be as close to hydraulically smooth as practical (Average surface roughness of approximately 1.6 μm or less for tube sizes on the order of 1 inch diameter).	N/A	Recommendation only. No information exists on the roughness of the sampling probes other than the transport and probes are constructed of 300 series stainless steel. (H-2-93374 Sheet 1)
6.4.5 – Condensation: Transport lines, collectors, and analyzers shall be designed to avoid condensation of vapors. Experimental or numerical analyses shall be performed to demonstrate the effectiveness of any design provisions that are intended to minimize or preclude the formation of condensation in sample transport systems.	Yes	The transport lines are Heat traced and insulated per H-2-93374 Sheet 1.
6.4.6 – Cleaning transport lines: The transport lines should be inspected annually for deposits and cleaned as necessary.	N/A	Recommendation only. See 6.3.4.8. Transport line cleaning is not required if visible deposits are not seen inside the sample probe nozzle (Letter 03-ESD-141)
6.5 – Gas and vapor sample extraction and transport: Consideration shall be given to extracting and transporting vapors and gases to determine where special system design may be required.	N/A	Gases are not part of the source term as documented in the permit modification and the final WDOH approval, source term is particulate only.
6.6 - Collection of particle samples	N/A	Title/Heading only

6.6.1 - General considerations: Critical issues for selection and operation of particle collection devices are: (a) appropriate presentation of the sample for real-time analyses or preservation of the sample for retrospective analyses; (b) adequate flow rates and detection efficiencies to meet sensitivity requirements; (c) minimal in-leakage within the collector; (d) minimal particle loss within the collection zone.	Yes	RPP-11595 analyzes the overall efficiencies and adequacy associated with the sampling system. RPP-CALC-55212 confirms these results.
6.6.2 – Filter media: Selection should be based on careful consideration of collection efficiency for the typical particle size in the duct, the area of the filter, the pore size, the filter's resistance to air flow, the background radioactive material of the filter, filter fragility, cost, self-absorption within the filter, and chemical solubility. Other considerations for filter selection are: (a) The filter shall be strong enough to maintain integrity at the required sample flow rates and during handling activities. (b)The sample holder shall provide adequate structural support while not damaging the filter. (c) The sample holder shall prevent sampled air from bypassing the filter. (d) The filters used for sampling airborne radioactive particles should have a minimum efficiency of 95%.	No	(a) Versapor 3000 Membrane 47 mm diameter disc (Item 66387) used in the record sampler. The filter is strong enough to maintain integrity at the required sample flow rates. (b) The sample holder is shown on drawing H-2-92489 Sheet 1. (c) No testing has been performed on the sample holder to ensure that sampled particulates are not bypassing the filter. The holder design utilized at the stack has been in service on numerous stacks on the Hanford site. (d) The filter efficiency range as documented in ANSI/HPS N13.1-1999 is 98.1 to 99.99.
6.7 – Collection of gas and vapor samples: Two general methods: (1) sampling with retention of specific constituents of the airstream (2) sampling without constituent separation	N/A	Title/Heading only
6.7.1 - Sampling with retention of specific constituents: (a) Requires a detailed knowledge of the chemical and physical properties of the radioactive material of interest, including possible interfering materials such as particulate matter and accompanying non-radioactive gases. (b) Sampling rates shall be established to ensure adequate sensitivity for the selected radioassay method and shall be compatible with the collector performance characteristics.	Yes	The record sampler draws a representative sample stream from the exhaust stack and passes it through a filter. The filter is periodically removed and analyzed for radioactive material in accordance with TF-OPS-006.

6.7.2 - Sampling without constituent separation: Volume collection and flow-through detectors are the two principal methods for total gas sampling or monitoring. Each situation will have to be evaluated individually to determine the feasibility of the gross measurement.	N/A	No sampling without constituent separation is used in this design.
6.8 - Sample volume measurement: For record sampling, if the stack or duct is PIC 1, measurement and control of the sample flow rate shall be used and the sample flow rate shall be varied in proportion to the flow rate through the stack or duct.	Yes	The record sampler vacuum pump for each VTA system is interlocked with the exhaust fans to operate only when an exhaust fan is operating. This ensures accurate sampling of particulate radionuclides in the exhaust air stream. A relay in the motor control center for the exhaust fans is wired to a switched outlet in the record sampler enclosure. The record sampler pump is plugged into this switched outlet. (RPP-15128, Section 4.1.6)
6.8.1 – Basic considerations: (a) The flow rate through a sampling system shall be measured and an indication of the value shall be displayed. (b) The flow detector shall be placed in the flow system in such a manner that it does not cause losses of aerosol particles or reactive radioactive gases.	Yes	AY296-VTA-FI-930 is a Dwyer® rotameter with display. AY296-VTA-FI-902 is Dwyer® Magnehelic® with display. (H-2-020206 Sheet 3) See attachment B for photos and P&ID.
6.8.2 – Volume of air sampled: (a) Continuous flow measurement shall be used for all stacks and ducts where significant emissions could occur, or if the flow rate can vary by more than ±20% during the sampling period. (b) When continuous flow measurements are employed, the flow rate should be recorded at intervals not to exceed 10 minutes.	Yes	The stack record sampler utilizes a rotameter for flow measurement (no data logging capabilities). H-14-020206 Sheet 3 The gas meter (AY296-VTA-HM-934) shown on page B-3 of Appendix B is a continuous flow totalizer.

6.8.3 – Flow rate control: (a) If sampling is performed at a constant flow rate, the flow controller shall maintain the flow rate within ±15% over conditions that corresponding to an initial pressure drop across the collector or analyzer to a value that is twice the initial pressure drop (b) If the stack has the potential to emit greater than 50% of the maximum allowable annual dose, a controller shall be used to maintain the ratio between sample flow rate and effluent flow rate within ±20% of a predetermined value. (c) The vacuum source used during a test of the controller shall have similar characteristics to the vacuum source used to draw air through the system in the field application.	Yes	The record sampler vacuum pump for each VTA system is interlocked with the exhaust fans to operate only when an exhaust fan is operating. This ensures accurate sampling of particulate radionuclides in the exhaust air stream. A relay in the motor control center for the exhaust fans is wired to a switched outlet in the record sampler enclosure. The record sampler pump is plugged into this switched outlet. (RPP-15128, Section 4.1.6)
6.9 – Leak checks: A sampling system shall be tested for leaks at the time of installation and at any time significant maintenance is performed or during an annual inspection.	No	Leak checks are currently not driven procedurally. TFC-WO-13-2168 was used in May 2013.
6.10 - Optimization and upgrading of new and existing system	N/A	Title/Heading only
6.10.1 - Defining the scope of the study: Optimization studies may address design issues covering all sampled and monitored stacks in a certain category, or it may apply to specific stacks that require special treatment. Once the scope of the optimization study is defined, it is necessary to specify radiological protection factors, constraints on access, applicability of certain options to achieve good mixing, and many other factors and limitations.	No	No optimization studies have been completed for stack 296-A-19.
6.10.2 - Identifying options and their consequences: A number of options will have to be considered in each case, with the implications of their adoption considered with respect to their contribution to representative sampling performance, consequences for workers' safety, and other factors affecting the decision. In some cases it may be advisable to conduct computational, laboratory, and/or field studies in support of the decision-making process.	No	Additional studies and tests would need completed to ensure that the stack is fully compliant with ANSI/HPS N13.1-1999.
6.10.3 - Use of decision-aiding techniques: Adequacy of documentation and reliability of any estimation and prioritization procedures used shall be a major concern and should enter into the record of decision.	Yes	TFC-PLN-02, Quality Assurance Program Description, is the top-level quality assurance document governing the tank farm quality assurance program.

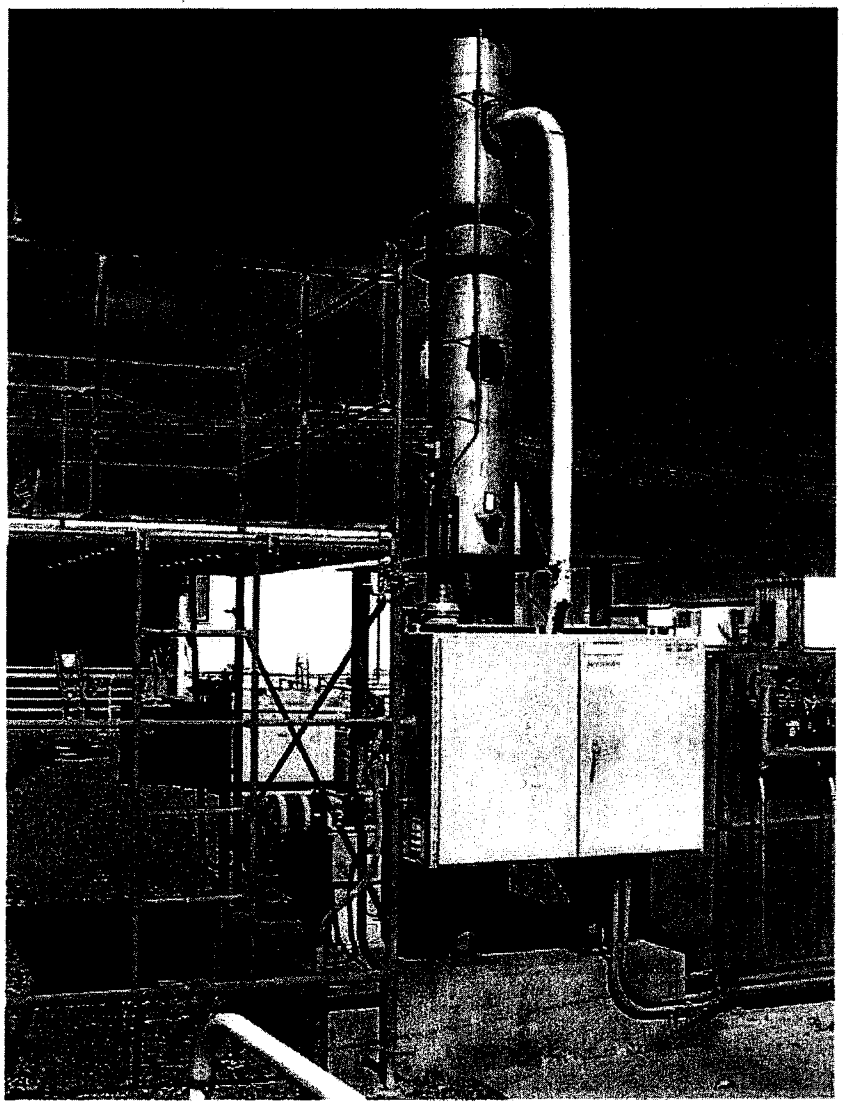
6.10.4 - Upgrading and retrofit of existing stacks: With the obvious exception of instances where the contaminant is gaseous and gas mixing is complete, it is difficult to defend the use of isokinetic, multi-nozzle sampling systems without demonstrating their compliance with this standard.	No	No testing has been completed to ensure this requirement is met.
ANSI/HPS N13.1-1999 Clause 7 – Quality Assurance and Quality Control		
Requirement	**Status**	**Compliance**
7.1 – Quality assurance plan: Every facility that conducts radiological air emissions sampling shall have a QA program that addresses the quality-related activities of the air sampling program. As a minimum, the QA Program shall address the quality aspects of the air sampling program in the following areas: (a) organizational responsibilities; (b) personnel qualifications; (c) administrative controls; (d) means for identification of sources; (e) basis for the selection of sampling points. The methodology for verification of compliance with mixing requirements shall be documented; (f) basis for selection of sampling and monitoring systems. The methodology for demonstrating compliance with performance requirements shall be documented; (g) sample collection and tracking procedures; (h) calibration methods and calibration procedures; (i) system operating procedures; (j) maintenance and inspection procedures; (k) procedure qualification; (l) data quality objectives and how they are accomplished; (m) audit and surveillance procedures; (n) corrective action program; (o) reporting and notification system; (p) program documentation requirements; (q) data analysis; (r) inspection status and disposition of deficient items and conditions.	Yes	TFC-PLN-71 is the QA program plan for Tank Farm Contractor Radioactive Air Emissions.

7.2 – Documentation: The record keeping system shall ensure that all results are well documented and retrievable for analysis, audits, and archival purposes.	Yes	TFC-PLN-02 Section 2.4 covers the document portion of the QA program.
7.3 – System characterization and documentation: The quality assurance program shall assure that the air sampling system and its components are characterized and documented.	Yes	TFC-PLN-02 Section 2.4 and 2.5 cover the document and work processes portions of the QA program. Specifically, the 241-AY-102 tank annulus ventilation exhauster stack numbered 296-A-19 is approximately 12.9 feet high above a thick concrete foundation with a 15 inch circular diameter.
7.3.1 - Source term: (a) Drawings of the ventilation system serving each sampled stack shall be maintained. (b) Modifications to the system performed during construction or anytime thereafter shall be described in detail. (c) The nature of the processes serving each stack shall be identified, including information about the identity of the radionuclides as well as their chemical and physical forms. (d) The air cleaning systems associated with each stack shall be identified as well as the probable nature of releases resulting from the possible failure of these systems.	Yes	TFC-PLN-02 Section 2.5 covers the requirements for instructions, procedures, and drawings. Specific drawings of stack 296-A-19 consist of the following: H-2-77324, H-2-77326, H-2-92481, H-2-92970, H-2-92971, and H-14-020206
7.3.2 - Effluent flow characterization: The results of studies to characterize the flow conditions of the effluents shall be documented.	Yes	Stack flow measurements are characterized via 3-VBP-155, *Air Flow Test for Tank Farm Stacks and Ducts*, in conjunction with locations specific data sheets.
7.3.3 - Design and construction: Documentation that describes the objectives of each stack sampling system, and includes or lists all radionuclides and their physical and chemical forms, shall be available.	Yes	RPP-15128, *System Design Description for AY/AZ Tank Farms Ventilation Tank Annulus Systems*, contains the documentation that describes system objectives for the entirety of the ventilation system at 241-AY-102.
7.4 – Training: Individuals involved in system operation, inspection, audits, surveillance, and calibrations shall receive training. Training requirements shall be determined by the responsible management organization and documented.	Yes	TFC-PLN-02 Section 2.2 covers the training portion of the QA program.

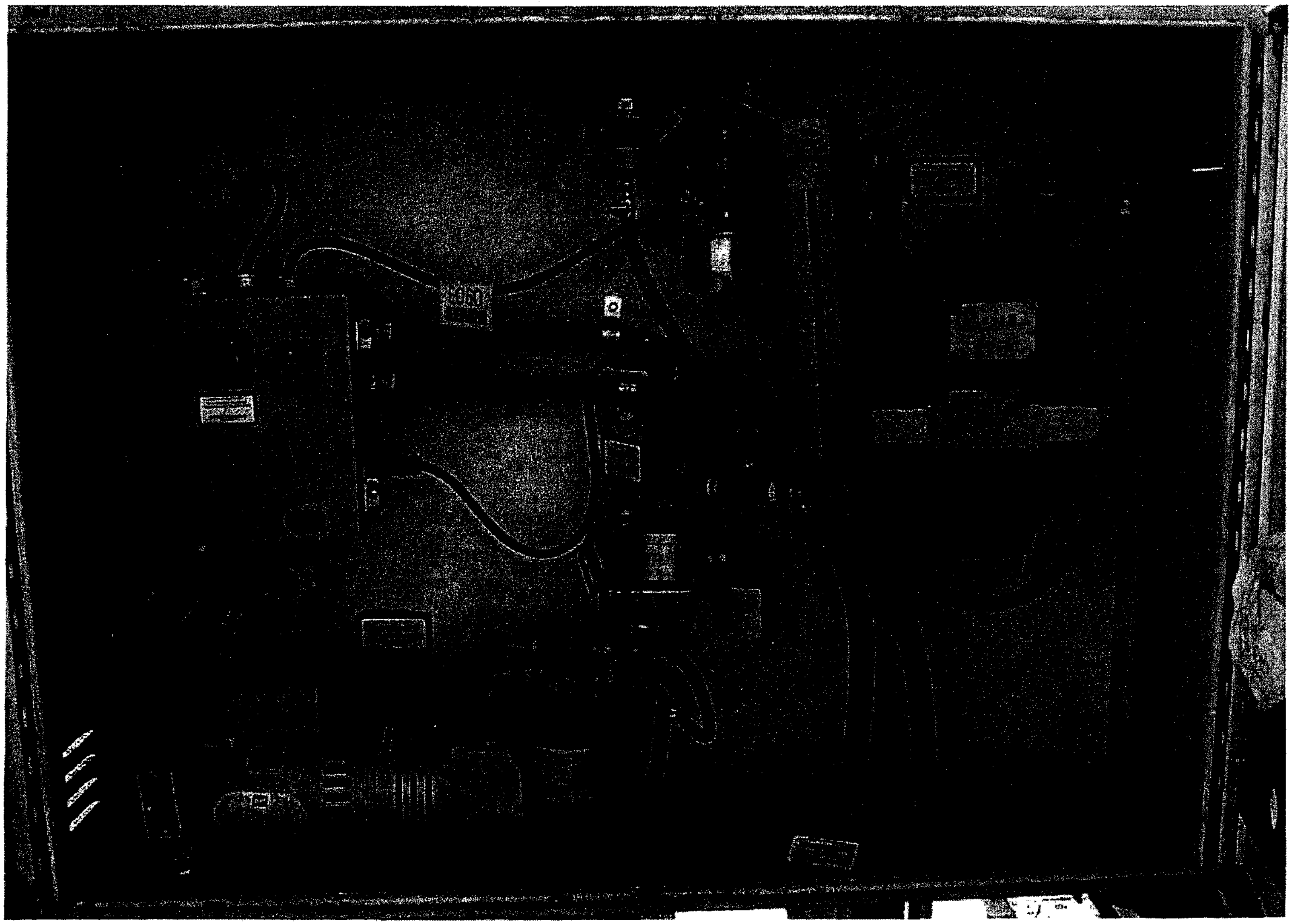
7.5 – Maintenance and inspection requirements: Inspection and maintenance processes shall be described in procedures and applicable records retained. Regularly scheduled inspections shall be performed at least once a year, and should include but not be limited to: (a) checks of nozzle position and orientation; (b) the measurements of the nozzle opening and checks for dust accumulation; (c) functional checks of instrumentation; (d) visual inspections for corrosion, physical damage, or dust loading to the sampling lines and equipment; (e) checks to ensure the tightness of all fittings and connections; (f) leak tests.	No	RPP-14698, Attachment B, identifies maintenance, inspection, and calibration requirements for all components in the 241-AY-102 VTA system based on a reliability-centered maintenance analysis. H-14-020206 Sheet 3. TFC-WO-13-2168 was completed May 2013. No procedurally driven inspections for the nozzles exist.
7.5.1 – Sampling system flow meter inspection: (a) The sampling system mass flow meters should be checked at least quarterly with a secondary or transfer standard, where a transfer standard is typically a calibrated mass flow meter placed in series with the unit to be tested. The flow rate at which the mass flow meter is checked shall be at a level that is within ±25% of the nominal design sampling rate of the system. (b) Check sampling flow rate through critical flow venturis at the start of each sampling period. (c) Inspect rotameters of sampling systems for the presence of foreign material at the start of each sampling period.	No	(a) No mass flow rate indicators are installed at the stack. (b) No critical flow venturis are used. (c) The stack is monitored through use of a rotameter. Readings are taken per TF-OPS-006. AY296-VTA-FI-930 is a Dwyer® rotameter with display and AY296-VTA-FI-902 is Dwyer® Magnehelic® with display are flow indicators. The rotameter is part of the record sampler. See attachment B for photos and P&ID.
7.5.2 – Continuous effluent flow measurement apparatus: On a quarterly basis, response checks should be made of the flow rate readings from in-stack equipment through use of a reference Prandtl-type pitot-static tube. If the flow sensor is a pitot tube, response checks shall be made at least quarterly to verify the functionality of any pressure gauges used in conjunction with the pitot tube readout.	No	No continuous flow measurement apparatus is in use.
7.6 - Calibration: Measurement and test equipment shall be calibrated using standards whose calibration is traceable to NIST or derived from accepted values of natural physical constants.	Yes	TFC-OPS-MAIN-C-07 requires all calibration to be traceable to NIST.
7.6.1 – Calibration of sampling system flow meters: All sampling system flow meters shall be calibrated annually using standards whose calibration is traceable to NIST.	Yes	The flow indicator used for the 241-AY-102 Annulus Exhaust Stack be functional tested annually via ET-02386. (Ref. H-14-020206)

7.6.2 – Calibration of effluent flow measurement devices: Effluent flow measurement system shall be calibrated annually against a reference method.	No	No continuous flow measurement apparatus is in use.
7.6.3 – Calibration of timing devices: Timing devices should be calibrated annually. Maximum error is 10 minutes per month.	Yes	The hour meter AY296-VTA-HM-934 used for the 241-AY-102 VTA stack be functional tested semi-annually via ET-04841 and 6-GM-355. (Ref. H-14-020206)
7.7 - System performance criteria: Assuring satisfactory sampling system performance requires the implementation of carefully planned design, inspection, and maintenance procedures.	Yes	TFC-PLN-02, Quality Assurance Program Description, is the top-level quality assurance document governing the tank farm quality assurance program.
7.8 - Technical guidance: QA programs are typically prepared in response to specific guidance documents.	Yes	DOE O 414.1C, Quality Assurance, for facilities and projects within the scope of work. DOE Environmental Management (EM) Quality Assurance Program (QAP) EM-QA-001

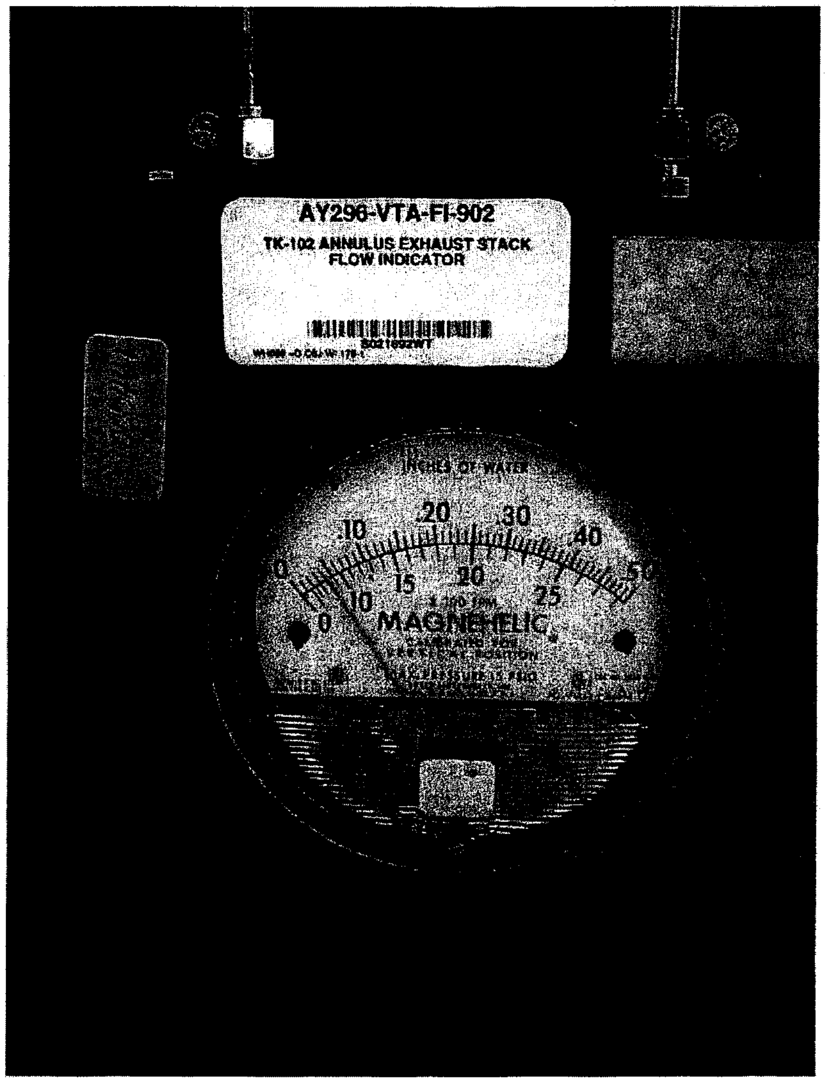
Attachment B – Miscellaneous Information



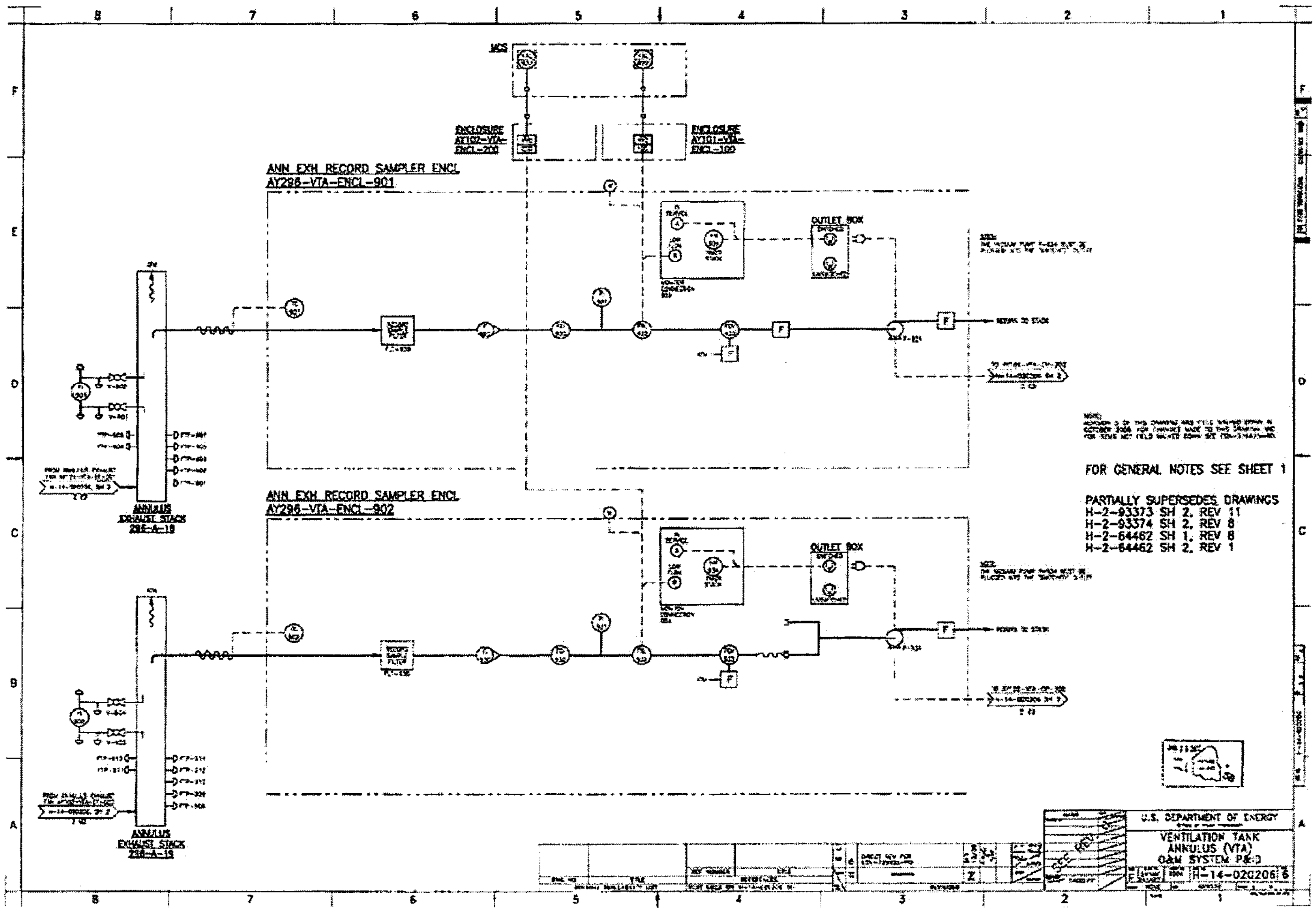
296-A-19 Stack at 241-AY-102



296-A-19 Stack Record Sampling Enclosure



AY296-VTA-FI-902 TK-102 Annulus Exhaust Stack Flow Indicator



H-14-020206 Sheet 3 Rev. 6

Attachment 3
13-ECD-0054
(17 Pages)

Analysis of AY Annulus Stack 296-A-19
Radionuclide Particulate Sampling Probe

RPP-CALC-55212, Revision 0

Dennis W. Bowser

CALCULATION COVER SHEET

Prepared For the U.S. Department of Energy,
Assistant Secretary for Environmental Management
By Washington River Protection Solutions, LLC., PO Box 850, Richland, WA 99352,
Contractor For U.S. Department of Energy, Office of River Protection, under Contract DE-AC27-08RV14800

1. Calc. No. RPP-CALC-55212
Rev. 0

2. Page i
2a. Total Pages: 17
3. Document Media ☐ Hard Copy ☒ PDF

4. Job/Project Name/Number	5. Calculation Title/Subject	6. Date
43584, Release 22	Analysis of AY Annulus Stack 296-A-19 Radionuclide Particulate Sampling Probe	6/4/2013

7. Design Agent's Name, Organization, & Phone No.	8. USQ Number ☒ N/A	9. PrHA Number ☒ N/A
Vista Engineering Technologies, Inc.	No. TF-13-0955-D R-0 RE WHEELER RE Wheeler USQ Evaluator Sign/Date 6/10/13	MM Harty No. 6-10-2013

10. Building/Facility No.	11. System	12. Structure	13. Equipment ID No. (EIN)	14. Safety Designation
241-AY	VTA	241-AY-102	N/A	☐ SC ☐ SS ☒ GS ☐ NA

15. Design Verification Required?	16. Related Documents/ECNs/EDTs	17. TBDs or HOLDS in Calculation?	19. Native File(s) Submitted?
☐ Yes ☒ No If Yes, as a minimum attach the one page checklist from TFC-ENG-DESIGN-P-17.	RPP-55197 Rev. 0 RPP-55198 Rev. 0	☐ Yes ☒ No 18. Approval Designator DA	☒ Yes ☐ No Word Document

20. Software Used	21. Program Name and Version	22. Software Validation/Verification Document Number	23. Technical Baseline Document
☒ Yes ☐ No	Deposition 2001a, Version 1.0	N/A	☒ Yes ☐ No

24. Distribution (Use Distribution Sheet Form # A-6000-135 as required)

Name	MSIN	Name	MSIN
Troy Farris	R1-07		
Gary Crummel	R1-51		
Mike Harty	R1-07		
Terry Kaiser	R1-07		
Del Scott Jr.	R3-26		
Sharok Khabir	S5-08		

Release Stamp

DATE:
Jun 11, 2013
HANFORD RELEASE

25. Clearance Review

Cleared For Public Release? Yes ☑ No ☐ | Restricted Use? Yes ☐ No ☑ | Restriction Type:

26. Trademark Disclaimer

Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States government or any agency thereof or its contractors or subcontractors.

Printed in the United States of America.

27. Clearance Review:

APPROVED
By Julia R. Raymer at 10:54 am, Jun 11, 2013

Signature:______________________ Date:_____
(Printed Name and Signature)

CALCULATION COVER SHEET

Prepared For the U.S. Department of Energy,
Assistant Secretary for Environmental Management
By Washington River Protection Solutions, LLC., PO Box 850, Richland, WA 99352,
Contractor For U.S. Department of Energy, Office of River Protection, under Contract DE-AC27-08RV14800

1. **Calc. No. RPP-CALC-55212**
 Rev. 0

2. **Page** ii

2a. **Total Pages:** 17

3. **Document Media** ☐ Hard Copy ☒ PDF

28. **Description of Issue/Revision** (Use continuation pages as required)

Provide an evaluation of the existing stack to ANSI/HPS N13.1-1999, Section 6.4.1, Depositional Losses, using a validated and verified copy of Deposition software for calculating the performance of the 241-AY-102 sampling system based upon the current configuration (e.g., size parameters, tubing bends, sampling system, etc.).

29. **Justification for Issue/Revision** (Use continuation pages as required)

This calculation is in support of Evaluation Schedule Requirement NOC 877.

30. **Key**

(a) Reason for Transmittal	(b) Disposition
1. Approval 2. Review	1. Approved 2. Approved w/comment 3. Reviewed no comment 4. Reviewed w/comment 5. Disapproved

31. **Approvals**

(a) Reason	(b) Disposition	(c) Title	(d) Printed Name and Signature	(e) Date	(f) MSIN
1	1	Design Agent	M.L. Vosk (Vista)	6-4-13	V1-00
1	1	Cover Sheet Checker	RE Mitchell (Vista)	6/4/2013	V1-00
1	1	Design Authority or DATR No.	WM Harty WM Harty	6/5/2013	R1-07
1	1	Engineering Manager	TR Farris Per Telecon WM Harty	6/5/2013	R1-07
2	1	Environmental Eng.	GM Crummel	6-5-13	R1-51
1	1	CSE	S. Khabir	6/5/13	R1-02

Subcontractor Calculation Review Checklist.

JRR 6/11/13

Page iii of ~~iii~~ v

Subject: Analysis of AY Annulus Stack 296-A-19 Radionuclide Particulate Sampling Probe

The subject document has been reviewed by the undersigned.
The reviewer reviewed and verified the following items as applicable.

Documents Reviewed: RPP-CALC-55212, Rev. 0

Analysis Performed By: Chad A. Hendrix (Vista Engineering)

- Design Input
- Basic Assumptions
- Approach/Design Methodology
- Consistency with item or document supported by the calculation
- Conclusion/Results Interpretation
- Impact on existing requirements
- ______________________________

Reviewer (printed name, signature) — Date: 5/20/13

Organizational Manager (printed name, signature) — Date: 6-3-13

VISTA ENGINEERING TECHNOLOGIES

Calculation Checklist

Document No.	RPP-CALC_55212	Rev.:	0
Calculation Title:	Analysis of AY Annulus Stack 296-A-19 Radionuclide Particulate Sampling Probe		
Preparer: (Print & Sign)	K.R. Roberson	Date:	6/4/13
Checker: (Print & Sign)	C. Hendrix	Date:	6/4/13

Verification Method: ☒ Design Review ☐ Alternate Calculation

Yes	No*	N/A	Criteria
☒	☐	☐	1. Purpose of calculation is completely defined.
☒	☐	☐	2. Any design interfaces have been identified and accounted for.
☒	☐	☐	3. Traceability has been established to associated drawings, components, systems, and structures.
☒	☐	☐	4. Applicable design code and other project requirements have been properly identified and satisfied.
☒	☐	☐	5. Appropriate modeling and calculation methodologies have been used.
☒	☐	☐	6. Any assumptions have been adequately described and, when necessary, justified.
☒	☐	☐	7. Input data and equations have been correctly selected and incorporated.
☒	☐	☐	8. Input data and information agree with their original sources.
☒	☐	☐	9. Mathematical derivations are correct, including dimensional consistency.
☒	☐	☐	10. Detailed analyses and numerical calculations are correct and have been completely documented.
☒	☐	☐	11. Any computer aided processing application and software program printouts have been uniquely identified and their input parameters and any data files have been completely documented and are correct and consistent with the calculation.
☒	☐	☐	12. Any computer aided processing application and software program outputs are consistent with inputs and have been accurately transcribed into the calculation.
☒	☐	☐	13. Software verification and validation are adequately addressed.
☐	☐	☒	14. Any safety margins are consistent with good professional practice.
☒	☐	☐	15. Results and conclusions address all points required by the calculation problem statement.
☐	☐	☒	16. Results and conclusions are consistent with any test results.
☒	☐	☐	17. Requirements, information, and equations from external sources have been properly referenced (including version/revision information).
☒	☐	☐	18. Results and conclusions are related to inputs and are reasonable considering those inputs.
☒	☐	☐	19. Checker comments have been dispositioned/incorporated and the design media matches the calculations
* If "No" is chosen, an explanation must be attached to this form			

RPP-CALC-55212, Rev 0 pg v

ATTACHMENT B – DESIGN VERIFICATION CHECKLIST

The verifier assures the technical accuracy of the document by performing administrative and mathematical checks as appropriate, and by evaluating the modification against the following questions:

Item	Verification	Results
1	Were the design inputs correctly selected and identified?	☒Yes ☐No ☐N/A
2	Are the assumptions necessary to perform the design or analytical activity adequately described and reasonable?	☒Yes ☐No ☐N/A
3	When necessary, are the assumptions identified for subsequent re-verification when the detailed design activities are completed?	☒Yes ☐No ☐N/A
4	Were appropriate design or analytical methods and computer programs used?	☒Yes ☐No ☐N/A
5	Were the design or analytical inputs correctly incorporated into the design, analysis or evaluation?	☒Yes ☐No ☐N/A
6	Is the design output reasonable compared to the design or analytical inputs?	☒Yes ☐No ☐N/A
7	Are the necessary design inputs for interfacing organizations specified in the design documents or in supporting procedures or instructions?	☐Yes ☐No ☒N/A
8	Have suitable materials, parts, processes, and inspection and testing criteria been specified?	☐Yes ☐No ☒N/A
9	Are calculations performed in accordance with the procedure TFC-ENG-DESIGN-C-10?	☒Yes ☐No ☐N/A
10	If TFC-ENG-STD-01 was/should have been design input, use Table C-3, Human Machine Interface Considerations	☒N/A

Engineer/Analyst: KR Roberson Date: May 31, 2013
Checker: C Hendrix Date: May 31, 2013

1. OBJECTIVE/PURPOSE:

Provide an evaluation of the existing stack from nozzle to filter sample holder (H-2-91069) to ANSI/HPS N13.1-1999, Section 6.4.1, Depositional Losses, using a validated and verified copy of Deposition 2001a Version 1.0 software for calculating the performance of the 241-AY-102 sampling system based upon the current configuration (e.g., size parameters, tubing bends, sampling system, etc.).

This objective is accomplished by repeating the analysis from 2002 described in RPP-11595 (Ref. 4), which established that the sampling system met ANSI N13.1-1969, with an updated software/model combination, and evaluating the results to ANSI 13.1-1999.

2. INPUT DATA:

- Ambient temperature: 25 degrees C
- Ambient pressure: 760 mm Hg
- Particle Density: 1 g/mL
- Particle Size: 10 microns
- Particle Distribution: monodisperse
- Free Stream Velocity: 5.4 m/s
- Flow in each nozzle assembly: 18.9 L/minute
- Flow in Transport Tube: 56.6 L/minute
- The combined nozzle assembles have an effective flow area of 13.24 mm

3. ASSUMPTIONS:

- Standard conditions.
- Monodisperse, 10 micron particles with 1 g/mL density.
- AY 102 Stack flow is 1,304CFM (used to derive Free Stream Velocity).
- Sample flow is 2.0 CFM (used to derive flow in the Transport Assembly).
- Each nozzle assembly carries a third of the total sample flow (used to derive flow in each nozzle assembly).
- Approximately half of each nozzle assembly is occluded in the fitting that connects the nozzles to the transport assembly (Figure 3), which goes to the sampler. The combined flow diameter is approximately 13.24 mm (used to model the expansion component).

4. METHOD OF ANALYSIS AND DESIGN:

The system simulated is dimensionally the same as used in RPP-11595 Rev. 0. The three nozzle assemblies and the transport assembly come together in a joiner that is modeled, in this calculation, with a combination of contraction and expansion elements .

The two probe types used in this calculation are: isokinetic and anisokinetic. The original intent seems to have been to run the system in isokinetic mode, where the flow in the sampling tube is the same velocity as the bulk flow. The previous analysis, RPP-11595, assumed the probes were run anisokinetically. In this calculation, results are obtained for both modes of operation. The three nozzle assemblies connecting the probes to the rest of the transport tubing are similar, differing slightly in the height of tube above the probe and the length of the horizontal section of tube after the bend. This is summarized in Table 1.

Table 1: Nozzle Assembly Dimensions from RPP-11595, Table 1.

Nozzle Assembly	Diameter mm	Vertical Tube m	Horizontal Tube m
1	10.92	0.06	0.35
2	10.92	0.04	0.18
3	10.92	0.04	0.05

Figure 1 shows Section A-A from H-2-93374 to give an overall perspective of the sampling system. The Transport assembly carries the sample flow from the outside of the stack to the equipment cabinet on the right hand side. The tube is shown with a slight slope, but is essentially vertical as installed. The model of the Transport Assembly is shown in Figure 4.

The nozzle assemblies are inside the stack. The longest one is shown in Figure 2, which includes a probe, rising tube, bend, horizontal tube, and a contraction.

The three nozzle assemblies are gathered together in a fitting, shown in Figure 3, discussed further below.

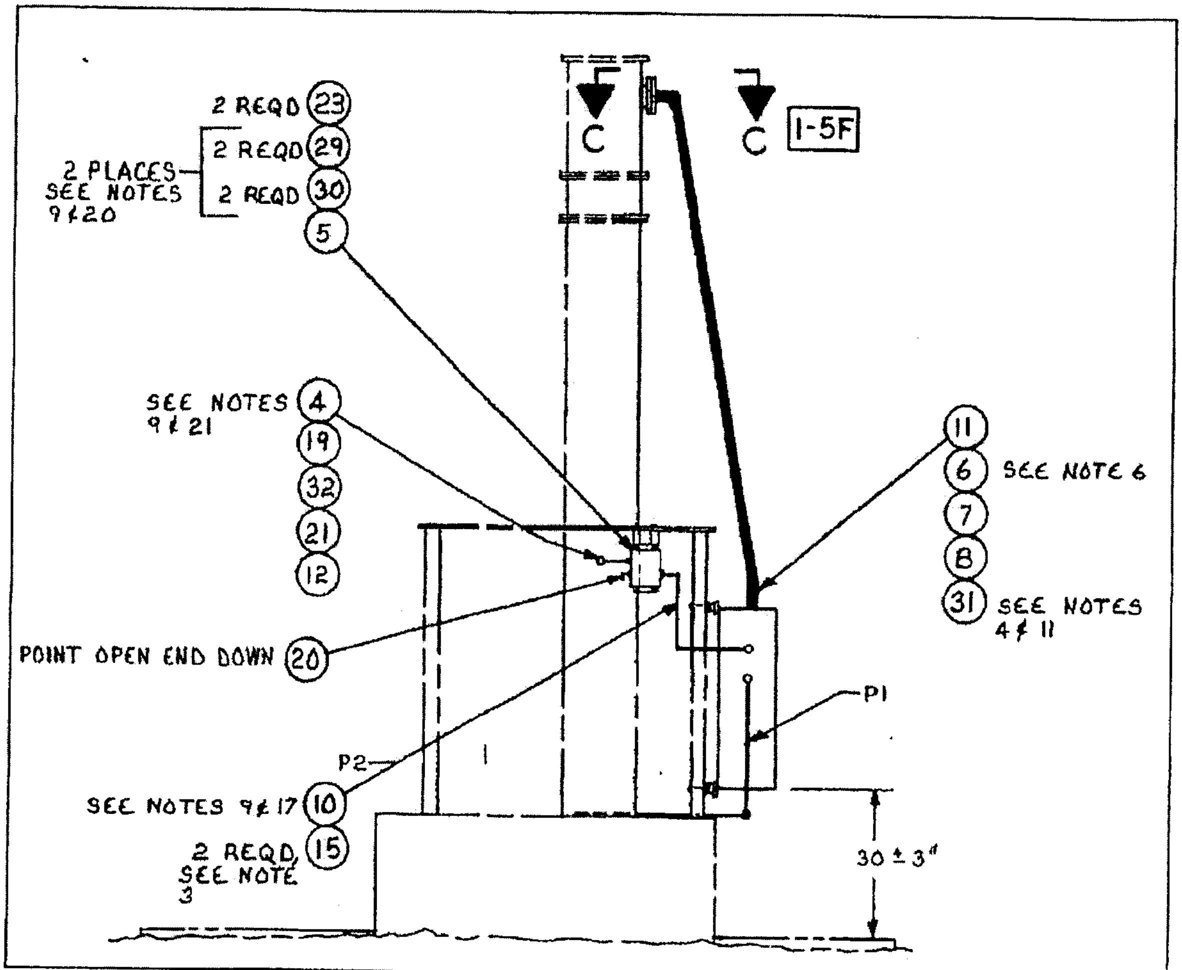


Figure 1: Transport Assembly, Section A-A from Drawing H-2-93374, Rev. 1, Ref. 7.

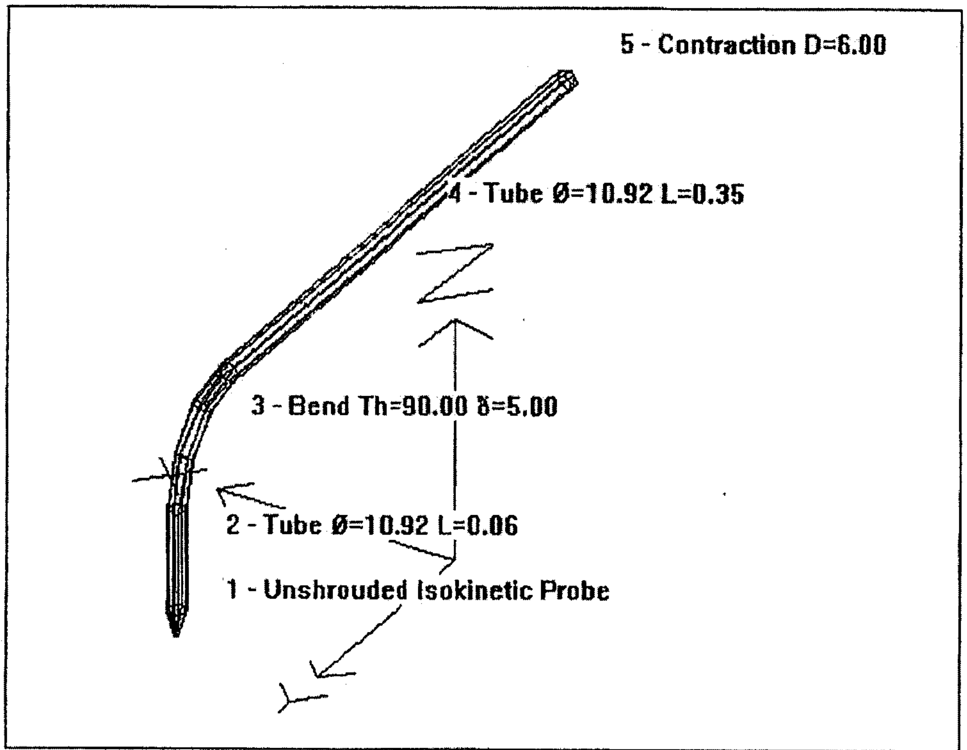


Figure 2: Nozzle Assembly 1 with Isokinetic probe and Contraction shown for Reference.

No reference for the assumed joiner efficiency of 98% was documented in RPP-11595 Rev. 0, so, instead, the current calculation models the joiner assembly as a contraction at the end of each nozzle assembly to represent the partial occlusion of each tube combined with an expansion whereby all three partially occluded tubes join the larger transport tube. The joiner uses the flow through the three nozzle assemblies combined (treated as a combined tube of approximately equivalent area) when modeling the expansion and the flow through each nozzle assembly, only, when modeling the contraction.

No laboratory data was found for something similar to the actual configuration of the joining section. Future work with Fluent, using a full computational fluid dynamics model, could refine the estimate of aerosol penetration by directly simulating the flow in the fitting in its as-built configuration.

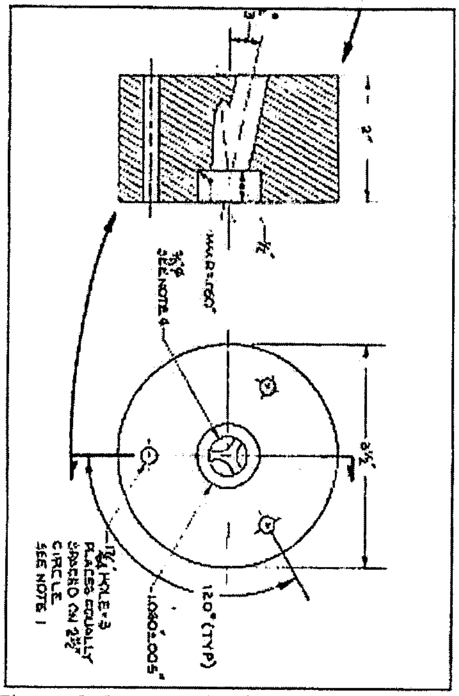


Figure 3: Front and Side View showing the Joiner (H-2-91069, Ref. 1)

The front view of the joiner, shown in Figure 3, gives an approximation of how the three nozzle assemblies mate to the connection with the rest of the sampling assembly. The transport assembly is shown in Figure 4, and takes the combined flow to the analyzer/sampler. The actual configuration of the joiner is not known, but it is assumed that at least half the diameter of each tube is occluded and the three tubes combined have an effective flow diameter of 13.24 mm. The transport tube has a flow diameter of 17.27 mm, so the connection is treated as an expansion element. The expansion ratio is slightly greater than 1.70, the minimum allowed for the correlation used in Deposition 2001a, Version 1.0.

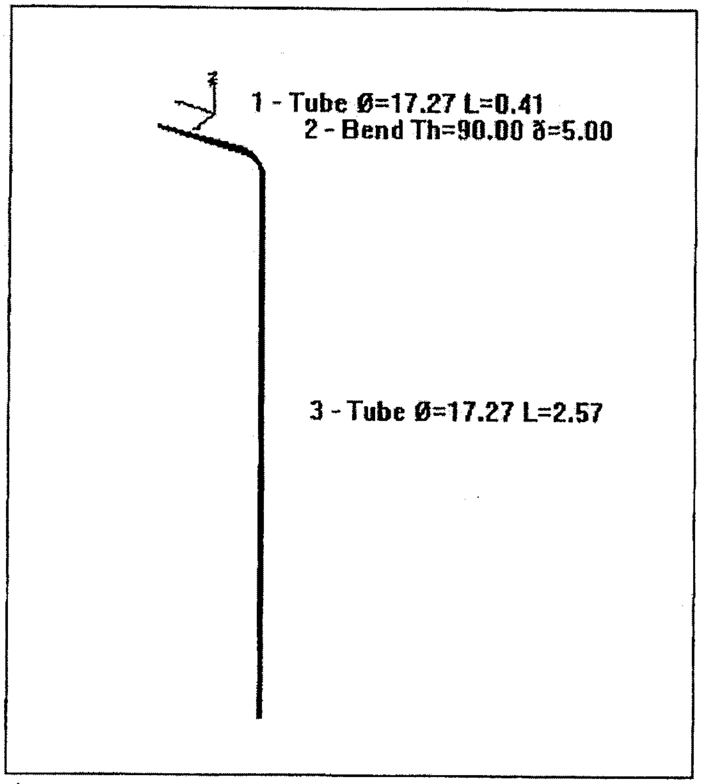


Figure 4: Transport Tube Configuration

5. COMPUTER SOFTWARE:

Aerosol penetration through the sampling assembly was calculated using Depositon 2001a, version 1.0, released March 1, 2002. Deposition 2001a output can be checked via alternate hand calculation for each component as demonstrated in the User's Guide.

Deposition 2001a is utility software that is used to streamline the use of aerosol penetration correlations derived from the technical literature. Each value derived from the program could be calculated by hand. Test cases from the Deposition user manual results were compared to results obtained on the computer used for this calculation. The checker used these comparisons to verify and validate the use of the software for this application.

Therefore, Deposition 2001a is exempt from the controls of TFC-BSM-IRM-STD-01, REV E-2, via the first listed case in Section 1.1. In addition, the checking process verified and validated the software installation and use for this project as required by the statement of work.

6. RESULTS:

The penetration percentage for each component of the sampling assembly was calculated using Deposition 2001a. The results are shown for each calculation by screen captured figures. The calculated aerosol penetration values are collected in Table 2.

Figure 5 shows the components of nozzle assembly 1. The component percentages are combined for the estimated total penetration for the part. Nozzle Assemblies 2 and 3 are shown in Figures 6 and 7.

```
TOTAL PENETRATION

Total Penetration:     62.6%
#           Component            Penetration
1           Tube                  99.6%
2           Bend                  66.2%
3           Tube                  96.0%
Stokes Number:        0.0925
Reynolds Number:        2344


NOTES:


<< Calculations were made with the best possible >>
<< extrapolations of the model(s).               >>
```

Figure 5: Estimated Aerosol Penetration for Nozzle Assembly 1.

```
TOTAL PENETRATION

Total Penetration:     64.3%
#           Component            Penetration
1           Tube                  99.9%
2           Bend                  66.2%
3           Tube                  97.9%
Stokes Number:        0.0925
Reynolds Number:        2344


NOTES:


<< Calculations were made with the best possible >>
<< extrapolations of the model(s).               >>
```

Figure 6: Estimated Aerosol Penetration for Nozzle Assembly 2

```
TOTAL PENETRATION

Total Penetration:    65.6%
#          Component          Penetration
1          Tube                99.9%
2          Bend                66.2%
3          Tube                99.4%
Stokes Number:       0.0925
Reynolds Number:      2344


NOTES:


<< Calculations were made with the best possible >>
<< extrapolations of the model(s).               >>
```

Figure 7: Estimated Aerosol Penetration for Nozzle Assembly 3

Figure 8 below shows the estimated aerosol penetration for the probe run as anisokinetic. Figure 9 shows the results for an isokinetic probe.

```
TOTAL PENETRATION

Total Penetration:   109.0%
#          Component          Penetration
1          Unshrouded Probe    109.0%
Stokes Number:       0.0925
Reynolds Number:      2344


NOTES:


<< Calculations were made with the best possible >>
<< extrapolations of the model(s).               >>
```

Figure 8: Estimated Aerosol Penetration for an Anisokinetic Probe.

```
TOTAL PENETRATION

Total Penetration:     90.1%
#            Component             Penetration
1            Unshrouded Probe       90.1%
Stokes Number:         0.0925
Reynolds Number:         2344


NOTES:


<< Calculations were made with the best possible >>
<< extrapolations of the model(s).               >>
```

Figure 9: Estimated Aerosol Penetration for an Isokinetic Probe.

Figure 10 shows the output of the analysis for the contraction that is at the end of each nozzle assembly.

```
TOTAL PENETRATION

Total Penetration:     89.7%
#            Component             Penetration
1            Contraction            89.7%
Stokes Number:         0.0925
Reynolds Number:         2344


NOTES:


<< Calculations were made with the best possible >>
<< extrapolations of the model(s).               >>
```

Figure 10: Estimated Aerosol Penetration through Contraction per Nozzle Assembly

Figure 11 below shows the output for expansion from the three nozzle assemblies with an effective diameter of 13.24 mm to the 17.27 mm diameter transport tube (slightly over the minimum area ratio of 1.70 for the correlation used in Depositon 2001a).

```
TOTAL PENETRATION

Total Penetration:     69.6%
#          Component          Penetration
1          Expansion           69.6%
Stokes Number:        0.1555
Reynolds Number:        4438


NOTES:


<< Calculations were made with the best possible >>
<< extrapolations of the model(s).               >>
```

Figure 11: Penetration Estimate for the Expansion Joint between the Nozzle Assemblies and the Transport Tube.

Figure 12 shows the results for the transport tube section of the assembly, depicted in Figure 4.

```
TOTAL PENETRATION

Total Penetration:     82.8%
#          Component          Penetration
1          Tube                97.3%
2          Bend                90.2%
3          Tube                94.3%
Stokes Number:        0.0701
Reynolds Number:        4438


NOTES:


<< Calculations were made with the best possible >>
<< extrapolations of the model(s).               >>
```

Figure 12: Estimated Aerosol Penetration for the Transport Section.

Results for all the components are collected in Table 2 together with estimates of the total penetration percentages for the sampling assembly.

Table 2: Depo2001a Results

Isokinetic Probe	90.1%			
Anisokinetic Probe	109.0%			
Nozzle Assembly	Tube	Bend	Tube	Total

1	99.8%	86.2%	96.0%	82.6%
2	99.9%	86.2%	97.9%	84.3%
3	99.9%	86.2%	99.4%	85.6%
Average Assemblies 1-3				84.2%
Contraction	89.7%			
Joint	89.5%			
Transport	82.8%			
Total Isokinetic	50.4%			
Total Anisokinetic	61.0%			

The penetration percentages of the three nozzles assemblies are averaged, since they act in parallel, before multiplying the result by the value for the joiner assembly and transport sections. The final component in the series is the type of probe, which results in two different values for the total penetration percentage for the overall assembly, depending on whether the system is operated isokinetically or not.

7. CONCLUSION:

The model used in this calculation is conservative, uses reasonable assumptions, and aerosol penetration estimates are made with the industry-standard software, Deposition 2001a. The aerosol penetration through the sampling assembly will be greater than 50 % when the probe is operated either isokinetically (50.5 %) or anisokinetically (61.0%) and thus meets the requirements of ANSI/HPS N13.1-1999, Section 6.4.1, Depositional Losses, for sampling systems.

8. REFERENCES:

1. Drawing H-2-91069, Rev. 0, titled "296-A-18 AND 296-A-19 RECORD SAMPLE PROBES", US Department of Energy, Richland, WA

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3. Procedure TFC-ENG-DESIGN-C-10, REV B-6, US Department of Energy, Richland, WA

4. Document RPP-11595, REV 0, "Analysis of AZ & AY Annulus Stack 296-A-18, 19, & 20 Radionuclide Particle Sampling Probes", US Department of Energy, Richland, WA

5. Standard TFC-BSM-IRM-STD-01, REV E-2, "SOFTWARE LIFE CYCLE STANDARD", US Department of Energy, Richland, WA

6. Standard ANSI/HPS N13.1-1999, "Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities", America National Standards Institute, Inc, 12 January, 1999, Health Physics Society, McLean, VA

7. Drawing H-2-93374, Rev. 1, titled "241-AY-102 ANNULUS EXHAUST STACK MONITOR INSTALLATION", US Department of Energy, Richland, WA

8. ANSI N13.1, 1969, Sampling and Monitoring Release of Airborne Radioactive Substances from Stacks and Ducts of Nuclear Facilities, American National Standards Institute/Health Physics Society, McLean, Virginia.